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ABSTRACT

Reported is a study of the implementation of the new Project Physics course in American high schools. In the summer of 1970, 457 teachers attending 14 National Science Foundation institutes and 98 of their school administrators provided information through discussions and questionnaires. At the four institutes at which an implementation conference was held, questionnaire responses were obtained twice from both teachers and administrators during the conferences. The participants of the remaining institutes were tested by mail. The questionnaires obtained personal information, school and school system data, attitudes, and opinions regarding the course adoption decision-making process. Conclusions made from the data analysis include: (1) the classroom teacher is most important in the adoption process; (2) adoption is most likely if the administration provides broad support; (3) the school most likely to adopt has a history of adopting other new courses; and (4) delay in adoption is increased by ineffective communication among school personnel. The characteristics of a teacher most likely to adopt a new course are presented in an ordered list. (Author/RS)

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Finally, we wish to thank the 10 institute directors and the 296 participants of the 1970 Project Physics summer institutes conducted at Bemidji State College, the University of California at Berkeley, Clark College, East Carolina University, Florida Technological University, Knox College, Northern Arizona University, Rensselaer Polytechnic Institute, Trinity University, and the University of Washington, who also contributed valuable data.

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ABSTRACT

The implementation of a new physics course was studied through the expectations of teachers and school administrators of adopting the Project Physics course. In the summer of 1970, more than 450 teachers attending 14 NSF summer institutes and nearly 100 of their school administrators provided information through discussions and questionnaires. Conclusions drawn from the discussions were consistent with statistical analyses of the questionnaire data.

RESULTS FOR ADOPTION OF NEW PHYSICS COURSES IN AMERICAN HIGH SCHOOLS

(1) The adoption process is initiated by the physics teacher who is the most important single person in the adoption process, but is often not fully aware of the importance of his role in adoption.

(2) Adoption is most likely if the teacher's proposal to adopt has a broad base of administrative support. The principal's support is the most important. Administrative support of others, in order of decreasing importance include: the department chairman, the superintendent, school board member(s), and the guidance counselor.

(3) A teacher most likely to adopt has the following characteristics:
- (a) Youthful;
- (b) Frequently seeks, and is sought out for, curricular advice;
- (c) Frequently attends professional meetings;

(d) Has recently enrolled in a course at a university;
(e) Is his school's science department chairman;
(f) Considers the adoption process as socially acceptable (dependable, sympathetic, sociable, cooperative, etc.) and professionally acceptable (productive, important, helpful, etc.);
(g) Considers the guidance counselor as supporting, professional, and important;
(h) Has discussed his interest in adoption with "significant others" in his school;
(i) Made numerous summer institute applications.

(4) A school most likely to adopt has a history of adopting other new courses, especially new science courses such as BSCS and CHEMS.

(5) Delay in adoption is increased by ineffective communication among schoolmen. Administrators need a year's advance warning of a desired course change to permit budgetary provisions.

POLICY SUGGESTIONS

(1) Fund, as part of the course development process, the early and continuous dissemination of information (through journals, meetings, and newsletters) to schoolmen about new courses.

(2) Fund teams of teachers and teacher educators to prepare and disseminate examples ("cases"), illustrating the adoption process under various conditions, and thereby improve the understanding of both pre-service and in-service teachers of the course adoption decision-making process.

(3) Modify teacher institute application forms to provide institute directors with information for selection of participants maximally likely to match their institute objectives. This report specifies the information directors need to select groups likely to adopt a new course; other kinds of information would be needed for other objectives. Guidelines to be used by institute directors in selecting participants for various objectives should be prepared.

CHAPTER I

INTRODUCTION

There are today, in the United States, more than 100 new science and mathematics courses in some stage of development.[1] Whatever the sources of funds for development of these new courses, each is faced with a similar problem -- that of adoption and implementation of the newly developed materials by schools. A survey of the teachers who attended the fifteen Project Physics summer institutes in 1968 or 1969 revealed that more than 40% of the teachers had failed to adopt the new course by the second September following the completion of the summer institutes.

Non-adoption of new curricular developments after teachers have been trained in their use is not unique to the Project Physics course. Marsh[2] reported an adoption rate (in 1960) of less than 50% by PSSC summer institute attenders. (PSSC and Project Physics adoption rates are not easily compared: the adoption of the former was viewed by many schools as a most appropriate post-Sputnik activity and adoption was stimulated by rapidly increasing Federal expenditures for science and science education; the adoption of the latter is occuring during a period of decreasing Federal spending on science and science education.)

Marsh concluded from the results of his 1961 study (published in 1964) that "Institute participation . . . does not seem to have been decisive as a reason for local budgeting for the use of PSSC materials."[3] This conclusion is probably still true today although, for the reasons given in the parenthetical note above, accepting the conclusion without question is risky.

How are adoption decisions made? Brickell's widely cited study[4] (1961) of the New York State Educational system concludes that "New types of instructional programs are introduced by administrators. Contrary to general opinion, teachers are not change agents for instructional innovations of major scope." This claim, although based only on data from the state of New York, conflicts with the unstated assumption inherent in the long-term approach of the National Science Foundation and the U. S. Office of Education that, given the necessary training in a new course of instruction, teachers will be able to initiate the procedures and decisions that result in the implementation of the course in their schools. The variety of decision-making processes, the diversity of personnel involved (often with only veto power), and the causes of delays in adoptions merit closer examination.

This study examines the decision-making processes in the adoption of a new course in American high schools. Since the Project Physics course was newly available for adoption, it was selected as the medium in which to study adoption procedures. We began by seeking variables which, for theoretical or intuitive reasons, seemed likely to be related to the probability of the new physics course being adopted by schools.

The variables, which are enumerated in Chapter III, can be categorized grossly into teacher and administrator[5] variables (personal, inter-personal, professional, and attitudinal); school variables, (characteristics of the school, school system, and area served by the school); and characteristics of the summer institutes attended. Interrelationships among the significant independent variables, once identified, were expected to give clues to underlying general factors important to the decision-making process.

A Paradigm for the Adoption of a New Physics Course

The literature of anthropology, politics, medicine, agriculture, education, and sociology was surveyed to determine the state of research on decision-making. From this survey, a paradigm was developed which we believed would characterize the conditions under which a course such as Project Physics could be most readily adopted.

The paradigm examined in this report is classified grossly into teacher-related, administrator-related, and school-related characteristics that were expected to favor early adoption of Project Physics. (Early adoption was defined to mean adoption by the second September following the completion of the teacher's summer institute.) Since the sources of suggestions for the hypothesized relationships were so diverse, and the research in the field was so varied, no attempt was made to predict the relative importance of the expected relationships.

While the existing research suggested a number of specific relationships that might be present, other possible relationships were intuited on the basis of our personal experiences with schools, teachers, and course adoptions. The characteristics of physics teachers, school administrators, and schools that we hypothesized were related to increased likelihood of adoption are listed below. Citations of related research are given in Chapter III of this report along with the tests of the hypothesized relationships. The relevant literature is discussed more thoroughly elsewhere by one of the authors of this report.[6]

Physics Teacher Characteristics Hypothesized to be Related to Increased Likelihood of Adoption of Project Physics

The teacher is the most important single person in making the physics course adoption decision. The adopter was expected to have the following characteristics:

1. Relatively young.
2. Socially inclined:
    a. frequently seeks curricular advice from others,
    b. frequently sought out for curricular advice,
    c. communicates more with colleagues,
    d. communicates more with "significant others" in the school's decision-making hierarchy,
    e. perceives adoption as a group effort.
3. Strong professional characteristics:
    a. more extensive formal education,
    b. recently completed education,
    c. frequently attends professional meetings,
    d. has relatively more contact with the professional literature,
    e. frequently enrolls in courses while in-service,
    f. publishes more.
4. Performance standards are not "conflicted."
5. Has relatively long tenure in his present job.
6. Teachers relatively more physics classes per day.
7. Is the department chairman.
8. Has more positive attitudes toward:
    a. "significant others" in the decision-making chain,
    b. physics,
    c. the adoption process.
9. Perceives adoption of the new course as a reduction in his work load.
10. Is strongly motivated to make a change.

School Administrator Characteristics Hypothesized to be Related to Increased likelihood of Adoption of Project Physics

School administrators are not likely to initiate the adoption process of a course such as Project Physics; they may, however, approve or deny a request for adoption after it is initiated by the teacher. Thus, no administrator characteristics would be expected to stimulate early adoption. Rather, any characteristics that were associated with the likelihood of early adoption, were expected to produce a delaying effect on adoption.

School Characteristics Hypothesized to be Related to Increased likelihood of Adoption of Project Physics

Schools most likely to adopt Project Physics were expected to have the following characteristics:

1. Has a history of moderately paced innovation in curriculum adoptions.
2. Is located in relatively high prestige areas (i.e. suburban).
3. Has relatively high per pupil expenditures.
4. Has a large student population.
5. Has a new or recently renovated building or science facility.
6. Adopted other new science courses early in their development.

Mechanisms for Gathering Data

Two methods were employed to gather data. The first method used questionnaires administered to 457 participants of the fourteen Project Physics institutes conducted in the United States during the summer of 1970.[7] The questionnaires (see Appendixes A, B, and C) sought information about the participants, their schools, and their school districts. The questionnaires also explored the participants' views regarding the adoption process and the difficulties associated with it; and explored the participants' attitudes toward physics, toward the process of adopting a new physics course, and toward others in the decision-making chain. Finally, in some cases, an attempt was made to assess the participants' understanding of scientists, the methods and aims of science, and the scientific enterprise.

The second method of data gathering used intensive face to face discussions between physics teachers and their administrators at four of the fourteen 1970 Project Physics summer institutes -- Florida State University, Kansas State University, San Diego State College, and Wisconsin State University. These four institutes hosted two-day conferences attended by 98 administrators (including some guidance personnel) from the schools or school systems which employed the 161 teachers enrolled in the institutes. The conferences featured extended periods of discussion among participants (teachers and administrators together) divided into groups of eight to ten persons each. The groups were given sets of discussion questions (see Appendix E) related to the research questions and were asked to probe the questions in depth. The aim of the discussions was not so much to obtain a group concensus as to acquire a greater understanding of the adoption process, of the factors contributing to delays in the adoption of new courses, and of ways and means of providing decision-makers with the kinds of information they need at the time they need it. The conclusions of the 29 groups constituted a second set of data.

The Sample

Table 1 presents a two-dimensional classification of the 555 respondents in this study. The sample is divided into groups of (1) teachers and administrators, and (2) implementation conference attenders and non-attenders. The sample included 477 men (85.9%) and 78 (14.1%) women.

TABLE 1
THE SAMPLE EXAMINED IN THIS STUDY

	Teachers	Adms.*	Totals
Implementation conference participants (4 summer institutes)	161	98	259
Not participants in an implementation conference (10 summer institutes)	296	-	296
Totals	457	98	555

*The 98 "significant others" attending the four implementation conferences were classified as "administrators." Their specific job responsibilities were as follows:

30 principals
27 guidance counselors
14 superintendents
 9 curriculum coordinators
 2 science supervisors
16 others (chiefly state department of education personnel and administrators not affiliated directly with any teacher in the institute)
___
98

This sample was selected because it was school men and women who were soon likely to be participating in the decision-making process about adopting the Project Physics Course (i.e. making a decision relevant to the research question). There was no point in seeking a sample representative of a larger segment of American teachers, administrators, or schools for whom the research question would be, to a large extent, hypothetical.

The sample of 457 physics teachers was not typical of all American teachers (or even American _physics_ teachers) because everyone in the sample had applied to, and had been accepted by, a summer institute. A random sample of nearly 500 American physics teachers that was drawn in a companion study[8] parallel to this one indicated that more than 40% of American physics teachers have never applied for any summer institute. Table 2a lists a few characteristics of the sample of physics teachers who participated in this present study. Data obtained in the companion study showed striking differences between a random sample of American physics teachers and teachers attending a Project Physics summer institute in 1968 or 1969: 29% of 238 items compared were significantly different at the 0.05 level. In general, institute attenders had overwhelmingly stronger professional characteristics, and more positive attitudes towards the adoption process and the persons who participate in it.

TABLE 2a
SELECTED PERSONAL AND PROFESSIONAL CHARACTERISTICS OF 457 TEACHERS FROM WHOM DATA WERE OBTAINED FOR THIS STUDY

% of men	86%
mean age	38 years
% with MS	66%
% who earned highest degree within the last 5 years	43%
% who attended a course for academic credit during past 2 years (exclusive of the Project Physics summer institute)	69%
% who hold, or have held, an officership in a local professional organization	28%
% who have published	8%

Various contingencies required the elimination of certain teachers from the sample. The 510 teachers enrolled in the 14 summer institutes and available for the study included approximately 25 foreigners who were not asked to complete the questionnaire. A few teachers were absent or declined to provide the desired information. Of the 457 teachers who completed and returned questionnaires, 382 (84%) indicated their intention to return to the school in which they had taught the previous year. The 75 teachers who were not returning to their previous schools were eliminated because many of the questionnaire items referred to teacher anticipation of future problems and interactions in the adoption process. Presumably, teachers in the process of changing schools would not be able to anticipate such problems and interactions accurately.

General Format of This Report

Chapter II summarizes what happened at the four summer institutes that hosted the two-day conferences attended by teachers and administrators. The substance of Chapter II is drawn from discussions of 29 small groups of teachers and administrators regarding problems that schools encounter in adopting educational innovations such as Project Physics. Chapter III presents a statistical analysis of the questionnaire data obtained from all fourteen participating summer institutes. The chapter tests specific hypotheses derived from the paradigm previously summarized. Chapter IV reports the results of a factor analysis of the variables significantly related to teachers' expectations of adoption. This was an attempt to identify unities underlying, and perhaps causes for, early or deferred adoptions. In Chapter V we summarize the findings of a companion study which investigated factors related to <u>adoption</u> rather than teachers' <u>expectations of adoption</u> of Project Physics. Chapter VI suggest guidelines and actions for funders of curriculum developments, teachers, administrators, teacher educators, and others who are interested in bringing about curricular changes in schools.

Caution must be exercised in generalizing the conclusions of this study. The study is confined to the adoption of a physics course by schools employing a group of teachers that is known not to mirror the general population of physics teachers or probably of school administrators. The adoption mechanism for a course involving only one teacher (as is often the case for physics) is likely to differ from the adoption, for example, of a reading series for the elementary school which builds sequentially year by year and involves several teachers.

We do not believe, however, that the conclusions are so highly subject-matter-oriented as to have no validity beyond physics courses. The Project Physics course is incidental to this study; it is a course which happened, conveniently, to be at the stage of development when it could be used profitably as an example with which to study how well many generalizations about innovation could be extended to the adoption of a science course.

Chapter I
Footnotes

1. Seventh Report of the International Clearinghouse on Science and Mathematics Curricular Developments, 1970, ed. by J. David Lockard, (College Park, Md.,: Science Teaching Center, University of Maryland, 1970), pp.xiv - xvii.

2. Paul E. Marsh, "Wellsprings of Strategy: Considerations Affecting Innovations by the PSSC," in Innovation in Education, ed. by Matthew B. Miles (New York: Bureau of Publications, Teachers College, Columbia University, 1964), p.263.

3. Ibid.

4. Henry M. Brickell, Organizing New York State for Educational Change (Albany: State Education Department, 1961), p.22.

5. The term "administrator" as used in this report has a somewhat broader than usual interpretation. It includes school personnel with non-teaching responsibilities supportive to the teacher -- principals, superintendents, guidance counselors, curriculum coordinators, and science supervisors.

6. John F. Yegge, "The Adoption of an Innovation in Physics Teaching" (unpublished doctoral thesis, Harvard University, 1971), pp.3-36.

7. The fourteen cooperating summer institutes were conducted at Bemidji State College, the University of California at Berkeley, Clark College, East Carolina University, Florida State University, Florida Technological University, Kansas State University, Knox College, Northern Arizona University, Rensselaer Polytechnic Institute, San Diego State College, Trinity University, the University of Washington, and Wisconsin State University (at Superior).

8. Yegge, ibid.

CHAPTER II

RESULTS OF THE SMALL GROUP DISCUSSIONS

Administrators from the schools of the summer institute participants were invited to join their teachers in two-day conferences at four of the 14 institutes. The conferences focused on the adoption and implementation of the Project Physics course and were attended by 98 school administrators and 161 teachers. Eighty-two of the administrators were directly associated with one of the institute participants; the remaining 16 were independent administrators and state department of education personnel who had been invited to attend the conferences because of their interest in the adoption and implementation of new courses.

The four two-day conferences had three purposes: they were intended 1) to inform administrators about the nature of the Project Physics course; 2) to help administrators and teachers resolve some of the difficulties they often encounter in trying to adopt such new courses in their schools; and 3) to give the investigators a first-hand familiarity with those difficulties and their potential resolutions. The first half of the conference schedule, as shown in Appendix E, set the stage for the small group discussions.

The small group discussions lasted two to three hours and each involved eight to ten teachers and administrators who discussed in detail a number of the problems related to the adoption of new science courses in schools. In addition to direct observation by two of the authors of these groups at work, one member of each group kept detailed notes on the proceedings. From these notes the recorders prepared summaries for oral presentations to general meetings of the small groups. Copies of the notes and the written summaries were obtained from each of the recorders. The following description is compiled from these summaries as well as from the personal direct observations of the researchers.

The membership of most of the small groups was selected by the investigators to create groups whose members had diverse backgrounds and roles. First, administrators and teachers from the same school system were assigned to different groups; insofar as possible, two persons from the same city were placed in different groups to reduce the constraints that persons from the same school might feel if they were placed together. Second, each group was formed to have about equal numbers of teachers and administrators. Since teachers outnumbered administrators in every conference, one or two groups at each conference were comprised solely of teachers. Third, at thee of the four conferences the groups were made as homogeneous as possible with respect to school size; in the fourth conference each group was made up of persons representing the broadest possible range of school size, grouped homogeneously by age. Furthermore, one group at one institute was teachers employed only in the Southern United States, while another group was made up entirely of physics teachers younger than thirty. In all, a total of 261 persons participated in 29 groups.

At the beginnings of the group discussions the groups were provided with sets of discussion questions (see Appendix D) divided into four general categories: (1) Factors affecting adoption, (2) The decision-making roles of various persons in the decision-making hierarchy, (3) The causes of adoption delays, and (4) The dissemination of information to adoption decision makers. The categories were sequenced in four ways so that different groups would start and end at different points. This permutation was intended to avoid the omission of topics because of a shortage of time or because of participant fatigue. Four of the groups failed to finish because of time shortage or fatigue; the remaining 25 groups completed the lists of discussion questions with thoughtful responses.

On most aspects of the adoption process a considerable amount of general agreement was observed among the 29 groups. Some disagreement occurred about the relationship between the shortage of funds and delays in adopting new courses. On the other hand, there was almost universal agreement in assigning to the teacher the chief responsibility for initiating the physics course adoption process and for successfully implementing it.

The recorder of one of the groups summed up the attitude of most of the groups:

> "Regardless of where the ideas originate or how or by whom the decisions are made to implement changes, unless the classroom teacher is in favor of those changes, they are doomed to failure."

The small groups agreed almost unanimously that there was no typical sequence of events in the decision-making process regarding new course adoptions except that the process almost always begins with the teacher and ends (at least in a formal sense) with the school board. The termination of the process in the school board was generally seen as a legal requirement with the board routinely endorsing recommendations submitted to it by the superintendent. The superintendent in turn, depending on the size of his school system, may only be endorsing a decision already recommended by a science supervisor, principal, or panel of teachers; in small school systems the superintendent's recommendation to adopt a new course may be based upon his personal investigation into the merits of a new course.

The sequence of events between the teacher's initiating the proposal to adopt and the final recommendation to adopt by the superintendent was not at all uniform. What actually occurs after the teacher's initial recommendation seems to depend upon the complex of personalities and positions in the hierarchical structure separating the teacher and the superintendent. The teacher, however, is most likely to take his proposal to his department chairman who in turn takes the suggestion (and often the teacher) to the principal. In larger school systems a science supervisor may stimulate interest among teachers by discussing the merits of new courses with them.

The small group discussions made it apparent that teachers and administrators view their roles in the adoption decision-making process quite differently and that neither communicates very well with the other. Several teachers related instances where their requests for innovations had been summarily dismissed. Administrators characteristically countered with the observation that teachers' requests for adoption often lack the kinds of information that administrators need to make an informed decision and to present an effective proposal to their own superiors. The physics teacher is often the only professional in a school with a very great knowledge of physics teaching and he may well feel that his recommendation for adoption should be sufficient to bring about a successful adoption. He thus may neglect the administrator's need to know: (1) how the new course is different from the previous course; (2) how the new course will affect children; (3) how the new course would fit into the total educational program of the school; and (4) how much the new course would cost.

Physics teachers are often not fully aware of the importance of their roles in the adoption decision-making process. The teacher whose innovative proposal fails to be accepted because it was ineffectively proposed may attribute the failure to administrative disregard for his professionality. When a teacher does not receive immediate support for his proposed innovation, he may not pursue the proposal further, interpreting a skeptical request for more information as a refusal. Thus, what begins as misunderstanding of one another's roles and as inneffective communication, often ends in frustration of attempts at innovation.

Guidance personnel were perceived as having essentially no role in the adoption process except insofar as they might observe that the current physics offerings are failing to meet the needs of many students and are being avoided by them. The 27 guidance counselors attending the conferences were quite aware that students often avoid taking physics in high school because of its reputed mathematical requirements and the consequent threat that a low grade poses to a student's grade point average and to his college admission prospects. These guidance counselors empathized more strongly with the students than with the physics teachers in this matter, but the counselors acknowledged that the communication links between themselves and the physics teachers were often so poor that considerable time might pass before they became aware of a new emphasis in physics teaching in their schools.

Ironically, the guidance counselor -- who has the least influence among the professional staff in the adoption process -- has the greatest influence when the newly adopted course is being implemented. Among the suggestions for improving communication between the guidance counselor and the physics teacher were: (1) to ask the counselor to participate actively in the adoption process, and (2) to invite the counselor to attend department meetings at which new courses and new methods of teaching would be discussed.

The science supervisor apparently exists only in larger school systems where it becomes economically feasible to employ a non-teaching specialist. The conference participants perceived the science supervisor in part as an initiator of curriculum change, but more as a source of information and encouragement to the teacher and as a person who could either conduct, or arrange for someone else to conduct, inservice training programs in new science courses.

In larger school systems the presence of the science supervisor is symbolic of a more highly formalized hierarchical structure. Such a formal hierarchy in large schools and school systems was identified by the participants as a cause of delay and sometimes as an obstacle to curriculum change. One group summarized it this way:

> "...City schools are more likely to become involved in elephantine committee structures, monolithic decision-making, and even after-the-fact involvement of teachers."

But, as other groups noted, larger schools and school systems can safeguard against hasty and ill-planned changes by instituting pilot programs before becoming fully committed to changes in their curriculums.

A difference in the adoption process was noted also on a state-by-state basis depending upon whether or not there was single state-wide adoption of a text or course (such as in Hawaii), an approved list of three to five books from which the local schools may choose (such as in Texas), or no state limitations on adoptions. Teachers and administrators from most states, however, seemed to feel that their freedom to adopt whatever programs suited the particular needs of their students most effectively was not seriously jeopardized by state regulations; other problems in the adoption process loomed far larger.

Only a few groups felt that the source of funds with which a new course was developed was an important consideration in making the adoption decision. Most groups offhandedly answered "no" to the question "Is the source of funds with which new courses are developed an important consideration?" and proceeded to other more interesting questions. One group, however, suggested that commercially developed courses might have a slight edge over courses developed with Federal funds because the commercially prepared courses, being less innovative, could be more easily taught by teachers without the necessity of special preparation. About one-fourth of the groups, on the other hand, believed that innovations were more likely to emerge from groups that were more concerned about a course's educational value than its salability, and thus that Federally funded groups had a small advantage. An undercurrent of suspicion surfaced occasionally regarding the motives of commercial publishers in introducing innovations as well as the care and educational sophistication going into their materials. Some participants reminded their colleagues that certain localities have a policy of refusing Federal assistance to education, but no group believed this to be an important consideration determining whether or not a course such as Project Physics would be adopted. Most of the participants believed that course materials would ordinarily be evaluated on their own merit without regard for the source of the development funds.

When asked to estimate the normal delay-time between the decision-maker's first knowledge of a new course of study, the decision to use it eventually, and the actual use of the course in the classroom; the small groups generally responded by first observing that the delay period would differ greatly depending upon a number of variables. New courses could be adopted almost immediately, for example, if the course was seen as urgently important by local citizens' groups; some school administrators observed that courses related to the drug-abuse problem had recently been adopted in their schools with virtually no delay at all.

Delays of as long as five years for a physics course adoption were estimated by some groups because of local and state adoption policies. Because many states (such as Tennessee) reconsider the texts on their approved list for each course on a five year cycle, it is inevitable that many localities will consider course changes no more often than that to insure maximum economy in the use of purchased materials. In this case, adoption of a new course which appeared on the scene at the beginning of a state's cycle could be long delayed unless state department of education approval is granted for an experimental program and the local school district underwrites the full expense of texts.

Shortages of funds to buy laboratory equipment and books was believed (in the summer of 1970) to be a major factor contributing to delays in course adoptions by most of the groups. The problem appeared to be most acute in schools in the South where fiscal obstacles were of such magnitude that other obstacles paled to insignificance by comparison. The conference at Florida State University, for example, was the only one that generated the idea that Federal assistance was needed to purchase laboratory equipment as well as to train teachers.[1] Although limited funding was seen as a source of delay in all regions of the country, the severity of the problem and the consequent expected length of the delay-time was greatest in the South.

Teachers perceived funding difficulties as a more significant deterrent to adoption than administrators did. Several administrators stressed the importance of adequate notice from teachers that additional funds might be needed, so that funds could be allocated at budget time. Such planning can accelerate the adoption process by a year. This is another example of an adoption delay that may occur because teachers are unaware of how such changes must be planned, justified, and implemented.

The question of teacher competence and the need for special teacher preparation to teach a course may diminish administrative support for a request to adopt a new course. The administrator may be particularly concerned when the new course is significantly different in content or approach from the course it supplements or replaces. Administrators candidly stated that if the physics teacher who has introduced Project Physics in his school resigns after a year or two, the school (now the owner of hundreds or thousands of dollars worth of new laboratory materials, texts, and multimedia materials) is faced not only with the difficult problem of replacing a physics teacher, but with the even more difficult problem of finding a teacher prepared to teach Project Physics. An administrator in Kansas asked: "Who teaches the teachers?" He, and several others -- teachers as well as administrators -- expressed dissatisfaction with teachers' colleges which, while considering general pedagogical techniques, often neglect specific course innovations, and produce teachers who need retraining the first day they enter a classroom.[2]

No delay in adopting a new course appeared to arise from the need to convince parents and students that a change in course would be beneficial. In most cases, if any such convincing were undertaken at all, it was done after the fact, and after it was evident that the change was a distinct improvement over what had been done before.

When asked how knowledge of new courses gets to the various persons involved in decision-making, the small groups indicated that the teacher himself appeared to be the primary source of information for all other professionals. The teachers reported that their sources of information were other teachers, professional publications (such as The Physics Teacher), textbook publishers, professional meetings, summer institutes, and newsletters. Many groups indicated that the most effective transmittal of information occured on a personal, face-to-face level. Accordingly, national publicity on new courses was not believed to be as effective as that published in state or local professional publications. Similarly, presentations and exhibits would probably have greater impact at state or local professional meetings than at national meetings. Numerous publications and appearances, however, pose obvious difficulties for course developers whose time and funds are limited.

The kinds of information that different persons in the decision-making chain would want varied, of course, with their responsibilities. Teachers expressed a need to know how a new course differs from their previous course with respect to its content, philosophy, and teachability. Administrators appeared to be more concerned with the objectives of the course and with research showing that the objectives are actually being met. In addition to course objectives, guidance counselors wanted information showing the effect of the course on student C.E.E.B., S.A.T., and advanced placement scores. Because parents and students, as mentioned before, were not believed to be part of the decision-making hierarchy, most groups saw no need to try to convey any particular information to them. Inclusion of parents and students was seen in terms of post-decision public relations rather than as a source of help in the decision-making process.

The information that schoolmen need, as reported earlier, can apparently be best conveyed on a personal level: inservice training courses, workshops, conferences, and summer school. Singled out as a particularly effective medium were brief conferences such as those they were attending. Both teachers and administrators welcomed the opportunity to inform the other of their own particular difficulties in such a nonthreatening situation. Administrators noted that the time they spent during these two-day summer conferences examining the Project Physics course was far more than they would ordinarily have devoted to it, even if they were seriously considering adoption of the course. A few teachers and administrators reported becoming personally better acquainted with each other during the short conferences focused on a common interest than they had in several years of professional affiliation.

Although the schoolmen noted a variety of difficulties accompanying the adoption of new courses such as Project Physics, the single most serious problem seemed to be communication: teachers and decision-makers communicate poorly; course developers convey information about their courses to schoolmen slowly and ineffectively; guidance personnel may be unaware of the possible adoption of a new course with a new approach; school administrators are sometimes unaware that their teachers are attending summer institutes and may be planning to request a change in the curriculum; parents and students are rarely consulted regarding course changes except as a public relations gesture. Possible course adoptions would be expedited if more information were quickly available through appropriate publications, conferences, etc. involving all types of persons who are involved in making such decisions.

Chapter II
Footnotes

1 Although the four institutes at which conferences were held received applications from teachers from all parts of the country, some priority was given to teachers from within a 500-mile radius of each summer institute. This was done to minimize the travel costs for the administrators invited to attend the two-day conferences and to establish as clear a regional difference among the four institutes as possible. The institutes in Florida and California seemed to have the greatest regional homogeneity.

2 So far, most Project Physics teachers have been trained in summer institutes. In the summer of 1970, about 500 of the Nation's 17,000 physics teachers attended a Project Physics institute; at that rate and assuming a course life of 15 years, less than half of the Nation's physics teachers will have received any summer institute training in Project Physics by the end of the 15-year period, even if <u>none</u> of the trained teachers leave the profession, retire, or die. (Mason and Bain estimate the "turnover rate" of American secondary and elementary school teachers to be 8% per year. (Ward S. Mason and Robert K. Bain, <u>Teacher Turnover in the Public Schools, 1957-58</u>, Office of Education Publication FS5.223:23002, cited in Alvin Renetzky and John S. Greene, editors, <u>Standard Education Almanac 1970</u>, (Los Angeles: Academic Media, 1970),p.108.) Applying this rate to the Nation's 17,000 physics teachers suggests that, while 500 teachers may be trained annually in Project Physics summer institutes, an increasing number of them leave the profession for one reason or another.)

Clearly, potential teachers should become acquainted with numerous new courses while they are in college. The time available, however, for curriculum and methods courses is brief (David E. Newton and Fletcher G. Watson, <u>The Research on Science Education Survey</u>

(Cambridge, Mass.: Harvard Graduate School of Education, 1969), pp. 57-60.) Furthermore, many physics teachers were enrolled for little or no time in such courses. The difficulties of improving teachers' pre-service educations are many.

CHAPTER III

ANALYSIS OF QUESTIONNAIRE DATA

The Questionnaires

Questionnaires and semantic differential instruments were completed by the entire group of 457 teachers and 98 administrators. The responses of 296 of the teachers were obtained from participants at the ten summer institutes that did not have implementation conferences. The statistical analysis of variables related to teachers' expectations of adopting Project Physics, however, was conducted on the entire pool of 457 teachers. The responses of a subsample of teachers and their administrators was used to establish the amount of correspondence between teachers' and their administrators' expectations of adoption - the dependent variable.

Questionnaire responses were obtained from both teachers and administrators twice during the conferences. An inventory was administered to the teachers and administrators at the first session of each conference after a brief introduction to the nature of the conference and a request for their assistance in the study. The opening session was structured to keep the teachers and administrators separated until after their responses on this initial instrument were completed in order to get their opinions in the most "uncontaminated" possible form. The inventories for the teachers and the administrators were very similar (see Appendixes A, B, and C); both sought personal information, school and school system data, and opinions regarding the course adoption decision-making process. The wording of a few items was modified for increased clarity to the different participating groups.

At the end of the conferences, a second set of measures (see Appendix C) was administered to both groups -- teachers and administrators. There were three distinct sections. First, four pages of the personal opinion portion of the initial questionnaire was repeated to assess the degree to which participant perceptions of the decision-making process had changed during the conferences.[1] Second, a seven page semantic differential questionnaire was inserted to probe the participants' attitudes toward themselves and others in the decision-making process as well as toward the process itself. Finally, Cooley and Klopfer's[2] "Test on Understanding Science" (TOUS) was included.

Since conferences were held at only four of the fourteen Project Physics institutes conducted in the United States in the summer of 1970, the remaining ten institutes were tested by mailed questionnaires similar to that in Appendix A. These questionnaires were designed to obtain personal and institutional information from teachers, as well as attitudinal data. The TOUS was not included.

Plan of Analysis and Interpretation of Data

The Dependent Variable

In the analysis of questionnaire data, the dependent variable was the teachers' expectations of adopting the new course. To seek significant differences related to when teachers expected to adopt the course, the teachers were considered in two groups: (1) "early adopters" and (2) "deferred adopters." Early adoption was defined as adoption by September 1971 (76% of the sample). The deferred adopters foresaw either a longer delay or no adoption at all. (Expectation of adoption, having a natural ordering, is ordinal.) Although two or three years will have to pass before the accuracy of the teachers' expectations of course adoption can be verified (through a follow-up study), the realism of the teachers' expectations of adoption was checked by comparing the responses of thirty-eight matched pairs of teachers and administrators (from the same school systems) with "matched" t-tests. The teachers and administrators differed very little ($p=0.85$). We concluded therefore that the teachers' expectations of adoption could be accepted as realistic.

Data Analysis

Relationships between the independent variables and the teachers' expectations of adoption were evaluated with contingency tables. The relationships expected to favor early adoption, presented in Chapter I, were nearly all monotonic, so Kendall's S statistic was computed to test for monotonicity. The Chi-squared statistic was computed if Kendall's S was found to be not significant since the Chi-square statistic is not sensitive to the internal ordering of the variables. (A brief discussion of the statistical tests and measures of association used is presented in Appendix F.)

In all contingency tables, (beginning with Table 2a) the observed cell frequencies, the expected cell frequencies, and the percentage distributions of both levels of the dependent variable for each level of the independent variable are shown. The expected cell frequencies, and the percentage distributions of both levels of the dependent variable for each level of the independent variable are shown. The expected cell frequencies are given in parentheses. Tables with very low significance levels (p greater than 0.10) are omitted. Throughout the study, the 0.05 level of confidence has been required to denote significance.

The independent variables shown to be significantly related to teachers' expectations of early adoption were factor analyzed to identify groupings caused by overlapping or redundancy among the independent variables that might provide clues to underlying elements responsible for variations in the dependent variable.

The Relationship of Teacher Variables to Expected Adoption Status

The teacher variables were divided into four categories: Personal Characteristics (such as teacher sex and age); Interpersonal Characteristics (such as the teachers' relationships with their schools' administrations); Professional Characteristics (such as teachers' memberships in professional organizations); and teachers' perceptions of, or attitudes toward, their schools, school administrations, themselves, physics, the adoption process, and the new physics course.

Personal Variables

Sex of the Teacher.

Men teachers were about twice as likely as the 47 women teachers to anticipate a delay in adoption of this course (25.8% *vs*. 12.8%). The Chi-square statistic (Yates' continuity corrected) however, was not significant ($p=0.08$). Table 2 shows the contingency table for sex of teacher by expectation of adoption.

Table 2b
Sex of Teacher *vs.* Expectation of Adoption of Project Physics

	Sex: Male	Sex: Female	
Early Adoption	74.2% 219 (224)	87.2% 41 (36)	260
Deferred Adoption	25.8% 76 (71)	12.8% 6 (11)	82
	295	47	342

$X^2_{1df}=3.078$ $\quad p=0.08$ (NS) $\quad$ tau-b=0.105

Age of the Teacher

A number of earlier studies (Sahlins and Service[3], Rogers[4], and Carlson[5]) state that innovations are initiated, or are more readily accepted, by young persons. Carlson, reported a significant negative correlation between adoption of new instructional approaches (modern math, team teaching, and programmed instruction) and the superintendent's age. Carlson perceived the superintendent as the initiator of the decision-making process for the innovations and schools studied, much as the physics teacher is perceived in this study.

The teacher's age was found, in the present study as in the earlier studies, to be significantly and negatively related (p=0.04) to his expectation of adopting Project Physics (see Table 3.). The trend was quite regular except that the percentage expectation of adoption for the youngest (and largest) group of teachers -- those under 31 -- broke from the trend. Perhaps this occurs because of the youthful teacher's inexperience and his relatively weak influence in the decision-making process.

Table 3

Age of Teacher vs. Expectation of Adoption of Project Physics

	< 31	31-36	37-42	43-48	49-54	> 54	
Early Adoption	78.4% 80 (77.5)	87.5% 63 (54.7)	71.2% 47 (50.1)	69.4% 34 (37.2)	71.4% 25 (26.6)	58.9% 10 (12.9)	259
Deferred Adoption	21.6% 22 (24.5)	12.5% 9 (17.3)	28.8% 19 (15.9)	30.6% 15 (11.8)	28.6% 10 (8.4)	41.1% 7 (4.1)	82
	102	72	66	49	35	17	341

S=3,153 SD =1,520 p=0.04 gamma=0.20

Interpersonal Variables

Several studies of the process of adopting innovations have stressed the importance of personal interrelationships in the decision-making chain. Carlson[6], for example, described the innovator as having such characteristics as: seeks advice from opinion leaders; has more friends at his own level in the decision-making hierarchy (not necessarily in the same institution) and interacts more with them; and is more often sought out by others as a source of information. Chadwick[7] pointed out that change is more readily effected if many persons participate in the change program. Foster, discussing cultural change, observed that "Much cultural change in guided programs is due to the acceptance of the innovator by the people among whom he is working; they will do much to please him because he is their friend."[8] Rogers stated that "opinion leaders have more social participation than their followers,"[9] and Margaret Mead[10] emphasized that an innovation must have popular support in the changing group to be successfully introduced.

We are in agreement with Lutz and Iannaccone[11] that classifying people by characteristics (such as age and sex) is a crude way to find predictors of social influence, and that a more sophisticated way is to consider the amount, frequency, and nature of the inter-actions displayed by the people whose behavior one is seeking to understand. Seven measures of the interpersonal characteristics of teachers were used in this study:

1. The number of "influential persons" the teacher feels supports his request to adopt Project Physics;

2. The number of "influential persons" the teacher feels understood the general nature of Project Physics before the summer institute began;

3. The number of administrators who knew the teacher was planning on attending a Project Physics institute before the institute began;

4. The number of "personal friends" the teacher perceives he has in the decision-making hierarchy;

5. The frequency with which the teacher sought advice from others regarding the adoption of new science courses;

6. The frequency with which other persons sought advice from the teacher regarding the adoption of new science courses; and

7. The amount of interaction the teacher believes he has with others who have about the same responsibility as he.

Of these seven variables, only two (numbers 4 and 7) were not monotonically related to the teacher's anticipation of an early adoption of Project Physics.

Number of Administrative Persons Supporting the Teacher's Proposal to Adopt Project Physics

The teachers were asked to select, from a checklist of eight persons in schools' decision making hierarchies, those who they believed enthusiastically supported their proposals to adopt Project Physics. The responses of 312 teachers are summarized in Table 4.

The numbers of persons supporting the teachers' proposals to adopt were trichotomized as shown in Table 5. Kendall's S statistic was highly significant; inspection of the contingency table reveals that only 66% of the teachers with no more than one supporter anticipated an early adoption while 93% of the teachers with more than three supporters

Table 4
Persons who 312 Teachers Believed Enthusiastically Supported their Proposals to Adopt Project Physics*

	Number	%
Superintendent	88	28.4
Science Department Head	183	59.0
Guidance Counselor	82	26.5
Outside Consultant	36	11.6
Curriculum Coordinator	60	19.4
Science Supervisor	71	22.9
Principal	190	61.3
School Board Member	37	11.9

Mean N supporters / teacher = 2.4

* No information was obtained as to the numbers of teachers working in schools that actually had each of these positions. A teacher's response, for example, that he did not have science supervisor support might mean that the science supervisor opposes the proposal or that there is no such person in his school.

Table 5
Teacher's Perceived Number of Supporters vs. Expectation of Adoption of Project Physics

	Number of supporters 0-1	2-3	4 or more	
Early Adoption	66.1% 76 (92.2)	85.1% 103 (97)	93.4% 71 (61)	250
Deferred Adoption	33.9% 39 (22.8)	14.9% 18 (24)	6.6% 5 (15)	62
	115	121	76	312

S = 5,800 SD = 1,190 $p = 5\times10^{-7}$ gamma=0.562

anticipated an early adoption. The gamma value of 0.562 means that, given knowledge of a monotonic relationship between the teachers' expectation of adoption and the <u>number of persons</u> supporting each of two teachers' proposals (as perceived by the teachers), one's error in predicting the anticipated order of adoption of the course for the two teachers (taking non-adoption to be equivalent to a very late adoption) would be reduced by 56% (from 0.5 to 0.22).

The relative importance to expectation of adoption of each of the eight persons in the checklist was also determined. This analysis (Table 6) indicated that support of seven of the eight persons was significantly, or almost significantly, related to expectation of adoption and that, of the eight, the support of the School Principal was markedly more important than that of any of the others. It appears that, if the teacher were to have support from only one person in the administrative hierarchy, the principal's support would usually be most effective; and, lacking that, a broad base of administrative support would be most desireable. The one exception to this appears to be the support of "outside consultants." The significance level (0.057) is not quite within the limits previously established and only 36 (12% of the respondents) indicated that they had outside consultant support, but the direction of the effect (reversed sign on Kendall's S) indicates that the support of an outside consultant, if related at all, is accompanied by an anticipation of delayed adoption.

Table 6

Summary of analyses of the perceived support of various persons in the school's administrative structure vs. expectation of adoption of Project Physics (N=312).

Source of Support	S	SD	Significance	Gamma	Fraction of teachers who anticipate early adoption who also perceive support N	perceive support %	do not perceive support* N	do not perceive support* %
Superintendent	-2666	1045	0.011	0.467	79	89.8%	169	76.1%
Science Department Head	-2976	1140	0.009	0.375	156	85.2	92	72.4
Guidance Counselor	-1984	1042	0.058	0.360	72	87.8	176	77.2
Outside Consultant	-1488	784	0.057	0.383	24	66.7	224	81.8
Curriculum Coordinator	-1860	939	0.048	0.444	54	90.0	194	77.6
Science Supervisor	- 372		NS		58	81.7	190	79.5
Principal	-7440	1683	0.00001	0.787	176	92.6	72	60.0
School Board Member	-1674	783	0.032	0.663	35	94.6	213	78.0

*This includes cases where the position does not exist. This grouping, in the absence of information regarding the existence of each position, is conservative and tends to understate the levels of confidence.

Number of Persons who knew the General Nature of Project Physics before the Summer Institute began

Table 7 summarizes the responses of the teachers indicating persons who, they believed, knew the general nature of the Project Physics Course before the summer institute began (see item 52, Appendix A).

Table 7
Persons in the decision-making hierarchy who the teachers believed knew the general nature of Project Physics before the summer began*

Persons	N	N times marked	%
Curriculum coordinator	332	51	15.4%
Guidance Counselor	331	57	17.2
Principal or Asst.Principal	334	160	47.9
Science Dept.Head	332	173	52.1
Science Supervisor	332	74	22.3
Superintendent	332	61	18.4
The Teacher himself	334	281	84.1

Mean number / teacher = 2.6

*As in Table 4, there is no information regarding how many of these positions actually exist in the teachers' schools.

The numbers of persons knowing the general nature of the Project Physics Course was trichotomized as shown in Table 8. Kendall's S statistic was highly significant; inspection of Table 8 reveals that only 53% of the teachers who indicated that no more than one person knew the general nature of Project Physics anticipated an early adoption, while almost 92% of those who marked four or more persons anticipated an early adoption.

Table 8
Number of Persons who the teacher indicated knew the general nature of Project Physics before the Summer Institute began *vs*. the expectation of adoption of Project Physics

	0-1	2-3	4-7	
Early Adoption	53.3% 49 (70.5)	82.4% 131 (122)	91.6% 76 (63.5)	256
Deferred Adoption	46.7% 43 (21.5)	17.6% 28 (37)	8.4% 7 (19.5)	78
	92	159	83	334

S=8,397 SD=1,400 $p=10^{-7}$ gamma=.615

The relative importance of the persons in the checklist to expectation of adoption was also examined. This analysis (Table 9) revealed that, of the seven persons in the list, prior knowledge of the nature of the course by all but two persons was significantly related to the expectation of adoption of Project Physics. The two persons whose prior knowledge of the course did not seem important to expectation of adoption were the science supervisor and the teacher himself. The apparent unimportance of the teacher's prior knowledge of the nature of the course to his anticipation of adoption is strange. There is nothing interpersonal about this particular item, however, and since prior knowledge on the part of the others in the list definitely implies some interpersonal contact, that may account for the difference.

Table 9

Summary of chi-square analyses (Yates' continuity corrected) of the persons in the decision-making chain whom the teacher indicated knew the general nature of Project Physics vs. expectation of Adopting Project Physics (N = 331-334)

Person knowing the general nature of Project Physics	X^2_1 df	p	Tau-b	DID N	DID %	DID NOT N	DID NOT %
				Fractions of teachers who anticipated an early adoption, depending upon whether the teacher believed that various "significant others" (did/did not) know the general nature of the Project Physics course before the summer institute began.			
Curriculum coordinator	7.21	0.007	0.157	47	92.2%	207	73.7%
Guidance counselor	14.06	0.0003	0.216	55	96.5	198	72.3
Principal or assistant	26.45	0.00001	0.288	143	89.4	113	64.9
Science department head	22.11	0.00001	0.265	151	87.3	103	64.8
Science supervisor	0.12	NS		55	74.3	199	77.1
Superintendent	5.21	0.023	0.134	54	88.5	200	73.8
Teacher himself	1.22	NS		219	77.9	37	69.8

Number of Administrators knowing of the Physics Teacher's intention of attending a Project Physics Summer Institute

In a further effort to examine relationships between expectation of adoption and teacher interpersonal characteristics, the teachers were asked to mark on a checklist of seven persons in the decision-making hierarchy those who were aware of their summer institute plans before the institute began (see item 54, Appendix A). The responses of 339 teachers to this item are summarized in Table 10.

Table 10
Persons in the decision-making hierarchy whom 339 teachers believed knew their summer institute plans before the institute began

Administrator	Number	%
Curriculum coordinator	91	27.1%
Guidance counselor	160	47.6
Principal or assistant principal	308	91.7
Science department head	247	73.5
School board member(s)	59	17.6
Science supervisor	96	28.6
Superintendent	185	55.1

Mean number / teacher = 3.4

The number of persons knowing the teacher's summer institute plans were partitioned into five categories as shown in Table 11. Kendall's S statistic was significant at the 0.0014 level. The gamma value of 0.292 shows the strength of the monotonic relationship. The percentage of teachers anticipating an early adoption rose regularly with increasing numbers of administrators whom the teacher had informed of his summer institute plans from a low of less than

64% among the least informed group to a high of 84% in the two most informed groups.

Table 11
Numbers of decision-makers knowing the teachers' summer institute plans before the institute began *vs.* expectation of adoption of Project Physics

	Number					
	0-1	2	3	4	5 or more	
Early Adoption	63.6% 21 (25.1)	66.2% 49 (56.3)	76.2% 64 (63.9)	84.1% 58 (52.5)	83.5% 66 (60.2)	258
Deferred Adoption	36.4% 12 (7.9)	33.8% 25 (17.7)	23.8% 20 (20.1)	15.9% 11 (16.5)	16.5% 13 (18.8)	81
	33	74	84	69	79	339

S=4855 SD=1491 p=0.0014 gamma=0.292

The relative importance of advance knowledge of the teacher's summer institute plans to expectation of adoption was assessed with Chi-square analysis for each of the seven groups of persons in the checklist. This analysis (Table 12) revealed that prior knowledge of the teacher's summer institute plans was significantly related to expectation of adoption for only two persons: the curriculum coordinator and the science department head. Since only two persons' prior knowledge is importantly related to the expectation of adoption and since the probability of early adoption increased with increasing numbers of persons knowing the teacher's summer institute plans (see Table 11) it appears to be useful to know <u>to whom</u> as well as to <u>how many</u> administrative persons the teachers tell their summer institute plans.

Table 12

Summary of contingency table analyses of the persons in the decision-making chain whom teachers indicated knew their summer institute plans before the institute began vs. expectation of adoption of Project Physics
(N = 339)

Fractions of teachers who anticipated an early adoption depending upon whether the teacher believed that various "significant others" (were/were not) aware of their summer institute plans before the summer institute began.

Person in the decision-making chain	$X^2_{1\,df}$ *	p	Tau-b	WERE N	WERE %	WERE NOT ** N	WERE NOT ** %
Curriculum coordinator	10.36	0.001	.18	81	89.0	175	71.4
Guidance counselor	0.443	NS		125	78.1	131	74.4
Principal or Assistant Principal	1.72	NS		238	77.3	18	64.3
Science department head	7.30	0.007	.16	198	80.2	58	65.2
School board members	3.49	0.062	.11	51	86.4	205	74.0
Science supervisor	0.010	NS		74	77.1	182	75.8
Superintendent	1.37	NS		146	78.9	110	72.8

* Yates' Continuity Corrected
** Includes cases where the position does not exist. This grouping, in the absence of information regarding existence of each position, is conservative and tends to understate the levels of confidence.

Teacher's number of personal friends among the decision-making hierarchy

The teachers were asked to indicate the persons, among seven in the decision-making hierarchy (see item 58, Appendix A), whom he considered to be personal friends (i.e. a first name basis). The responses of the 329 teachers who responded to this item are summarized in Table 13.

Table 13
Persons in the decision-making hierarchy whom 329 teachers considered to be personal friends

	Number	%
Curriculum coordinator	73	22.2%
Guidance counselor	228	69.3
Principal or assistant principal	232	70.5
School board member	83	25.2
Science supervisor	76	23.1
Science department head	221	67.2
Superintendent	81	24.6

Mean number / teacher = 3.0

The probability that expectation of adoption was independent of the numbers of personal friends teachers have in the school's administrative structure was 0.11 and, hence, the two were not considered to be importantly related. At the very best, there was a weak suggestion that teachers with more numerous personal friendships with decision-makers have a greater anticipation of an early adoption.

Perceived friendship between the teacher and each person in the checklist was examined for a relationship with expectations of adoption to determine if friendship of some persons in the decision-making hierarchy influence teachers' expectations more than that of others. Only one of the seven tests, however, approached the 0.05 level of significance. (See Table 14).

The frequencies of the teachers' giving and seeking advice regarding adoption of a science course

Another measure of the interpersonal characteristics of a teacher contemplating the adoption of a new science course was the amount of advice he sought from others regarding the possible adoption, and the amount of advice others sought from him. The teachers in the sample were asked to indicate the numbers of times both interactions had occurred during the preceding twelve months (see items 63 and 64, Appendix A). Both tests showed a relationship (p less than 0.01) between the amount of teacher contact with others regarding new course adoption and the expectation of adoption of Project Physics. In both cases (Tables 15 and 16) the percentage of teachers anticipating early adoption increased regularly (Teacher sought advice, 65% - 84%; Teacher sought out for advice, 63% - 86%) with increasing contact with others on the subject.

The amount of teacher interaction with other teachers

The tests of the advice giving and receiving relationships among teachers regarding course adoption may be confounded. While it appears that one is measuring the amount the teacher seeks and is sought out for advice regarding a new course adoption, the measurement might be of teacher gregariousness. If the gregariousness hypothesis were appropriate, the teachers who were more interactive would be expected to have a higher rate of adoption.

Table 14

Summary of chi-square analyses of the persons in the decision-making chain whom teachers indicated were personal friends vs. expectation of adoption of Project Physics (N = 329)

Person in the decision-making chain	$X^2_{1\ df}$ *	p	Tau-b	Fractions of teachers who anticipated an early adoption depending upon whether the teacher considered that various "significant others" (were/were not) personal friends. were N	were %	were not N	were not %
Curriculum coordinator	3.74	0.053	.12	62	84.9	187	73.0
Guidance counselor	1.21	NS		177	77.6	72	71.3
Principal or assistant principal	.92	NS		181	78.0	68	70.1
School board member	0.47	NS		60	72.3	189	76.8
Science supervisor	2.34	NS		52	68.4	197	77.9
Science department head	1.35	NS		172	77.8	77	71.3
Superintendent	0.429	NS		64	79.0	185	74.6

*Yates' continuity corrected

60

To test this possibility, teachers were asked how much interaction they believed they had with other teachers (see item 62, of Appendix A). Table 17 presents the contingency table pitting the levels of teacher interaction against the expectation of adoption of Project Physics. There was no evidence ($0.5 < p < 0.75$) that the relationships between the amount of course adoption advice the teachers gave and received and the likelihood of the course being adopted are confounded. The weak trend that appeared, in fact favored the alternative to the gregariousness hypothesis.

Table 15
The number of times during the past 12 months the teacher asked another for advice on adoption of a new science course vs. expectation of adoption of Project Physics

	0	1	2	3 or more	
Early Adoption	65.3% 49 (56.8)	73.3% 44 (45.4)	74.6% 53 (53.8)	83.6% 107 (97.0)	253
Deferred Adoption	34.7% 26 (18.2)	26.7% 16 (14.6)	25.4% 18 (17.2)	16.4% 21 (31.0)	81
	75	60	71	128	334

S=4266 SD=1445 p=0.0032 gamma=0.279

Table 16
The number of times during the past 12 months the teacher was asked for advice on adoption of a new science course vs. expectation of adoption of Project Physics

	0	1	2	3	4 or more	
Early Adoption	63.0% 34 (41.2)	70.5% 31 (34.6)	72.9% 51 (53.5)	76.3% 29 (29.0)	85.9% 110 (97.7)	255
Deferred Adoption	37.0% 20 (12.8)	29.5% 13 (9.4)	27.1% 19 (16.5)	23.7% 9 (9.0)	14.1% 18 (30.3)	79
	54	44	70	38	128	334

S=5190 SD=1430 p=0.00006 gamma=0.327

Table 17
Teacher's relative amount of interaction with other teachers vs. expectation of adoption of Project Physics

Interaction level (compared with other teachers)

	More	Same	Less	
Early Adoption	76.3% 116 (115.3)	74.4% 119 (121.9)	83.3% 25 (22.8)	260
Deferred Adoption	23.7% 36 (36.7)	25.6% 41 (38.1)	16.7% 5 (7.2)	82
	152	160	30	342

S=278 p=NS

Interpersonal characteristics of physics teachers do appear to be related to their expectations that the new physics course will be adopted. Only two of the measures of interpersonal activity on the part of the teacher were not significantly related to expectation of adoption.

Teacher's Professional Characteristics

Carlson[12], in his Allegheny County study, lists several professional characteristics of superintendents that were correlated with earliness of adoption of educational innovations (team teaching, the "new math," and teaching machines). Some of the characteristics of the superintendents that were positively related to early adoption were: 1) amount of formal education, 2) amount of participation in professional meetings, 3) length of tenure in the present position, 4) lack of "conflict"[13] in performance standards, and 5) recency of formal education. These characteristics were thought to be possibly relevant to the present study.

Several items in the questionnaires explored the teacher's professional characteristics. These were classified into three categories:

The Teacher's Professional Preparation

The teacher's professional preparation was evaluated with four measures:

Highest Degree

The teachers' highest academic degrees (see item 3, Appendix A) were classified into five levels:

Degree	Distribution N	%
Bachelor's	31	9.1
Bachelor's plus graduate work	87	25.4
Master's	60	17.5
Master's plus graduate work	161	47.1
Doctorate	3	0.9
Total	342	100.0

Recency of Highest Degree

The recencies of the teachers' highest degrees (see item 4, Appendix A) were classified into three levels:

Year of highest degree	Distribution N	%
Before 1956	49	14.4
1956-1965	144	42.2
After 1965	148	43.4
Total	341	100.0

Undergraduate Major

The teachers' undergraduate majors (see item 59, Appendix A) were classified into two categories:

Undergraduate major	Distribution N	%
Science or mathematics	243	71.1
Other	99	28.9
Total	342	100.0

TOUS Score

The teachers' total scores on the Test on Understanding Science (TOUS)[14] were trichotomized:

TOUS total score	Distribution N	%
Below 42	18	15.8
42-49	67	58.8
50 or higher	29	25.4
Total	114	100.0

None of the four measures was significantly related to the teachers' expectations of adopting the new course. There is no evidence, then, that the professional preparation of physics teachers is importantly related to expectation of adoption of Project Physics.

The Teacher's Relationship with the Science Teaching Profession

The teacher's relationship with the science teaching profession was estimated with nine measures:

Professional Meetings

The numbers of "distant" (more than one hour's drive distant) professional meetings the teachers had attended during the past 12 months (see item 2, Appendix A) were classified into three levels:

Number of meetings	Distribution N	Distribution %
0-1	166	49.4
2-3	118	35.1
4 or more	52	15.5
Total	336	100.0

Reading Professional Journals

The number of professional journals the teacher reads routinely (see item 5, Appendix A) was trichotomized:

Number of journals	Distribution N	Distribution %
0-2	144	44.6
3-4	131	40.6
5 or more	48	14.9
Total	323	100.1

Courses for Academic Credit

The recency of the teacher's latest course for academic credit preceding the 1970 summer institute (see item 6, Appendix A) was classified into three levels:

Year of latest course	Distribution N	%
Before 1966	36	10.6
1966-1967	68	20.1
1968-1969	235	69.3
Total	339	100.0

Membership in Local Professional Organizations

The number of local professional organizations to which the teacher belongs (see item 8, Appendix A) was divided into three levels:

Number of organizations	Distribution N	%
0-1	107	32.5
2	122	37.1
3 or more	100	30.4
Total	329	100.0

Leadership in Local Professional Organizations

Whether or not the teacher had ever been an officer of any of the local professional organizations to which he belongs (see item 8, Appendix A) was investigated:

Officership in local professional organization	Distribution N	%
Was an officer	92	28.0
Never was an officer	237	72.0
Total	329	100.0

Membership in National Professional Organizations

The number of national professional organizations to which the teacher belongs (see item 9, Appendix A) was divided into three levels:

Number of organizations	Distribution N	%
0	68	20.5
1	140	42.2
2 or more	124	37.3
Total	332	100.0

Leadership in National Professional Organizations

Whether or not the teacher had ever been an officer of any of the national professional organizations to which he belongs (see item 9, Appendix A) was investigated:

Officership in National professional organization	Distribution N	%
Was an officer	5	1.5
Never was an officer	327	98.5
Total	332	100.0

Publications

Whether or not the teacher had ever published any journal articles (see item 10, Appendix A) was investigated:

Teacher publications	Distribution N	%
Had published	27	8.2
Had not published	304	91.8
Total	331	100.0

"Conflict" in Performance Standards

Whether or not the teacher experienced a "conflict"[15] in his teaching performance standards (see items 26 and 27, Appendix A) was investigated:

Conflict in standards	Number of teachers N	%
Standards not conflicted	202	59.1
Standards conflicted	140	40.9
Total	342	100.0

Only one of the above nine variables was significantly related to the anticipated adoption of Project Physics: the recency of the teacher's latest course for academic credit preceding the 1970 summer institute. Table 18 shows that, fractionally speaking, teachers who had taken a course for academic credit during the preceding two years, compared with those who had not, were substantially more likely to anticipate an early adoption (82% vs. 64%).

Table 18
Year of teacher's last course for academic credit *vs.* expectation of adoption of Project Physics

	Year: Before '66	'66-'67	'68-'69	
Early Adoption	63.9% 23 (27.4)	61.8% 42 (51.7)	82.1% 193 (178.9)	258
Deferred Adoption	36.1% 13 (8.6)	38.2% 26 (16.3)	17.9% 42 (56.1)	81
	36	68	235	339

S=4745 SD=1236 p=0.00014 gamma=0.416

While this evidence does not allow the conclusion that taking college courses for credit <u>causes</u> teachers to be more likely to adopt a new physics course, it is apparent that the two are related. Teachers who enroll in courses for credit, for whatever reasons, tend to be those who more commonly seek new course materials.[16]

None of the remaining eight variables measuring teachers' professional behaviors was significant as a predictor of expectation of adoption at the 0.05 level of confidence. One variable however, the number of professional meetings the teacher had attended during the preceding 12 months, showed a relationship at the 0.10 level which, on inspection, revealed a sharp increase in the anticipation of adoption for teachers attending four or more such meetings annually. Accordingly, the levels of professional meeting attendance were collapsed from three to two as shown in Table 19. The contingency table revealed that teachers who attended four or more professional meetings annually were significantly more likely to anticipate an early adoption of Project Physics than those who attended meetings less frequently (89% vs. 75%).

Table 19
The number of professional meetings attended by the teacher during the preceding 12 months *vs*. expectation of adopting Project Physics

	Number of meetings 0-3	Number of meetings 4 or more	
Early Adoption	74.7% 212 (218)	88.6% 46 (40)	258
Deferred Adoption	25.3% 72 (66)	13.4% 6 (12)	78
	284	52	336

S=2300 SD=1425 p=0.05 gamma=0.446

The Teacher's Professional Relationship with his School

Three measures of the teacher's professional relationship with his school were employed:

Tenure in present job

The number of years the teacher had held his present position (see item 47, Appendix A) was divided into four levels:

Number of years	Distribution N	Distribution %
0-2	100	29.2
3-6	104	30.4
7-10	91	26.6
11 or more	47	13.7
Total	342	99.9

Time devoted to teaching Physics

The fraction of his teaching time the teacher devotes to teaching physics (see item 48, Appendix A) was divided into three levels:

Fraction of time teaching physics		Distribution N	%
less than 1/3		147	43.6
1/3-2/3		111	32.9
more than 2/3		79	23.4
	Total	337	99.9

Leadership in the Science Department

Whether or not the teacher was the school's science department chairman (see page 1, Appendix A):

		Distribution N	%
Department chairman		84	24.7
Not department chairman		256	75.3
	Total	340	100.0

One of the three variables was related to the teacher's anticipation of adoption: whether or not the teacher was also the science department head. Table 20 shows that early adoption was anticipated by 86% of the teachers who were chairmen compared with 73% who were not department chairmen.

No simple relationship linked the number of years the teacher had held his present position with his anticipation of adoption. Table 21 shows a markedly higher adoption expectation at the extremes of the periods the teachers had held their present positions (i.e. less than three years and more than 10 years). Although statistical variability may account for the obtained value of chi-square one time in eight (p less than 0.12), the increased anticipation of adoption

Table 20
Whether or not the teacher was a department chairman vs. expectation of adopting Project Physics

	Department Chairman Yes	Department Chairman No	
Early Adoption	85.7% 72 (63.8)	72.7% 186 (194.2)	258
Deferred Adoption	14.3% 12 (20.2)	27.3% 70 (61.8)	82
	84	256	340

$X^{2*}_{1\ df}=5.20$ $p=0.023$ Tau-b=0.132

* Yates' Continuity Corrected

appears where it might be reasonably expected (among the teachers new to a school -- a "new broom" sweeping clean -- and among the long established teachers).

Table 21
Length of time the teacher has held his present position *vs.* expectation of adopting Project Physics

	Length of time (years) 0-2	3-6	7-10	11 or more	
Early Adoption	81.0% 81 (76.1)	71.2% 74 (79.1)	71.4% 65 (69.2)	85.1% 40 (35.7)	260
Deferred Adoption	19.0% 19 (23.9)	28.8% 30 (24.9)	28.6% 26 (21.8)	14.9% 7 (11.3)	82
	100	104	91	47	342

$X^2_{3\ df}=5.89$ p=NS

Teacher Perceptions of the School Administration, Himself, Physics, the adoption process, and the Project Physics course

With a few exceptions, the measures of teacher perceptions were semantic differential items constructed for this study (see pp.SD 1-7, Appendix A).

Teacher Perceptions of the Superintendent, the Guidance Counselor, and themselves

The teachers' perceptions of their superintendents, their guidance counselors, and themselves were evaluated with 23 antonym pairs that are listed in Table 22. The respondents were instructed to mark one of seven levels separating each antonym pair in the way that they felt best described the topic (eg. "superintendent") being investigated. The aggregate of data for each antonym pair for each topic was then arrayed in a frequency distribution for ease in trichotomizing the test sample into approximately equally populated sublevels. In a few cases, skewed distributions did not permit a three-way division; these data were dichotomized. The Kendall's S statistic and the chi-square statistic were then computed for the three levels vs. the expectation of adoption of Project Physics. Table 22 shows that 7 of the 69 variables examined were significant at the 0.10 level - approximately what one would expect due to random variation. Thus, there is no evidence of any relationships linking the teachers' perceptions of their superintendents, their guidance counselors, and themselves with the expectation of adoption of Project Physics.

Teacher Perceptions of Physics

Teachers' perceptions of Physics were evaluated with 12 antonym pairs which are listed in Table 23. Once again the responses to the antonym pairs were divided into three approximately equally populated levels and were examined for relationships with expectation of adoption. Table 23 presents the significance levels of the analyses. Contingency tables are presented for the significantly related variables.

Physics as Important

Table 24 shows the relationship between the teachers' perceptions of physics as important and expectation of adoption of Project Physics. Interestingly, an early adoption of the course was anticipated most by teachers who perceived physics as either very important or as relatively unimportant; the relationship was non-monotonic as shown by the nonsignificant S and the significant chi-square. (The respondents on this semantic differential item tended to rate physics as very important. In order to trichotomize the variable, the five -- of seven -- lowest categories were combined. Thus, on a relative scale, the teachers

Table 22

Summary of the significance levels of semantic differential item responses measuring teacher's perceptions of "superintendents," "guidance counselors," and "physics teachers" interacting with expectation of adoption of Project Physics. (N = 303-315)

Adjective Antonym Pair	Superintendent p X^2_2 df	Superintendent p S	Guidance Counselor p X^2_2 df	Guidance Counselor p S	Physics Teacher p X^2_2 df	Physics Teacher p S
Important-Unimportant	NS	NS	NS	.028	.041	NS
Productive-Unproductive	NS	NS	NS	NS	NS	NS
Democratic-Authoritarian	NS	NS	.084	NS	NS	NS
Friend-Enemy	NS	NS	NS	.049	NS	NS
Wise-Foolish	NS	NS	NS	NS	NS	NS
Comforting-Threatening	NS	NS	NS	NS	NS	NS
Helpful-Obstructive	NS	NS	NS	NS	NS	NS
Kind-Cruel	NS	NS	NS	NS	NS	NS
Cooperative-Antagonistic	NS	NS	NS	NS	NS	NS
Orderly-Cluttered	NS	NS	NS	NS	NS	NS
Predictable-Unpredictable	NS	NS	NS	NS	NS	NS
Reliable-Unreliable	NS	NS	NS	NS	NS	NS
Aggressive-Passive	NS	NS	NS	NS	NS	NS
Saving-Wasteful	NS	NS	NS	NS	NS	NS
Trustworthy-Untrustworthy	NS	NS	NS	NS	NS	NS

Table 22 (continued)

Adjective Antonym Pair	Superintendent		Guidance Counselor		Physics Teacher	
	p		p		p	
	X^2_2 df	S	X^2_2 df	S	X^2_2 df	S
Sociable-Unsociable	NS	NS	NS	NS	NS	NS
Dominant-Submissive	NS	NS	NS	NS	NS	NS
Cheerful-Solemn	NS	NS	NS	NS	NS	NS
Dependable-Undependable	NS	NS	NS	NS	NS	NS
Strong-Weak	NS	NS	NS	NS	NS	NS
Sympathetic-Unsympathetic	NS	.026	NS	NS	NS	NS
Supporting-Undermining	NS	NS	NS	.032	NS	NS
Professional-Unprofessional	NS	NS	NS	.034	NS	NS

Table 23
Summary of the semantic differential item responses measuring teachers' perceptions of "<u>physics</u>" interacting with the expectation of adoption of Project Physics (N=315-323)

Adjective Antonym Pair	p: X^2_2 df	p: S
Important-Unimportant	0.0003	NS
Productive-Unproductive	NS	NS
Democratic-Authoritarian	0.001	NS
Comforting-Threatening	NS	NS
Helpful-Obstructive	NS	NS
Orderly-Cluttered	NS	0.09
Predictable-Unpredictable	NS	NS
Simple-Complex	NS	NS
Easy-Difficult	NS	NS
Sociable-Unsociable	NS	NS
Cheerful-Solemn	0.045	NS
Dull-Interesting	NS	NS

who indicated physics importance as "six" on a scale of seven were in the middle group.) A quasi-replication of the relationship described in Table 24 in terms of actual adoption (using a sample of 216 teachers who had already completed the adoption decision-making process) yielded a non-significant relationship (p=0.6). The teachers who perceived physics as least important, however, still had the highest adoption rate (71% vs. 56% and 59% in the middle and upper groups respectively).[17]

Physics as Democratic

Table 25 shows the relationship between the teachers' perceptions of physics as democratic (as opposed to authoritarian) and the expectation

Table 24
Teacher perception of the importance of physics *vs*. expectation of adoption of Project Physics

	Physics important: less	inter-mediate	more	
Early Adoption	100.0% 25 (19)	65.5% 76 (88.4)	79.7% 145 (138.6)	246
Deferred Adoption	0.0% 0 (6)	34.5% 40 (27.6)	20.3% 37 (43.4)	77
	25	116	182	323

$X^2_{2\ df}=16.30$ p=0.0003 Tau-b=0.046

Table 25
Teacher perception of physics as "democratic" *vs*. the expectation of adoption of Project Physics

	Physics-democratic: Low	Medium	High	
Early Adoption	83.1% 123 (113)	64.2% 68 (81)	81.2% 52 (49)	243
Deferred Adoption	16.9% 25 (35)	35.8% 38 (25)	18.7% 12 (15)	75
	148	106	64	318

$X^2_{2\ df}=13.36$ p=0.001 Tau-b=0.082

of adoption of Project Physics. Here, as in the case of the teachers' perceptions of the importance of physics, the relationship was interestingly non-monotonic; the expectation of adoption of Project Physics was sharply higher at the two extremes of the independent variable with there being little difference whether the teacher perceived physics as either democratic or authoritarian but with much lower expectation of adoption for teachers who perceived physics as neither.

Physics as Cheerful

The third of the significantly related semantic differential items involving teacher perception of physics -- Physics: Cheerful/ Solemn -- is shown in Table 26. As in the previous two relationships, the relationship was not monotonic; and as before, expectation of adoption was greater at the two extremes.

Table 26
Teacher perception of physics as "cheerful" *vs*. expectation of adoption of Project Physics

	Physics: Cheerful			
	Low	Medium	High	
Early Adoption	91.9% 34 (28.1)	72.4% 113 (118.2)	75.4% 95 (95.7)	242
Deferred Adoption	8.1% 3 (8.9)	27.6% 43 (150.8)	24.6% 31 (30.3)	77
	37	156	126	319

$X^2_{2\ df}=6.21$ $p=0.045$ Tau-b=0.055

We have found three semantic differential items measuring the teachers' perceptions of physics which were non-monotonically related to the teacher's anticipation of adopting Project Physics. In all three cases the measure of association, Tau-b, was very small which means that little improvement in one's ability to predict the dependent variable, given the independent variable, is provided by knowledge of the relationship. None of these three variables could be shown to be significantly related to the actual adoption of Project Physics on quasi-replication in the study by Yegge referred to earlier.[18]

Another measure intended to estimate the teachers' perceptions of physics was their responses to a questionnaire item asking which high school course they would choose to teach if they were to teach only one (see item 60, Appendix A). "Physics" was indicated as the preferred choice in 64% of cases. Since there were very few responses to the categories labeled "earth science," "English," "General Science," and "Social Studies," they were classified with the "other" category in order to avoid a contingency table having many cells with low populations. The chi-square computation, however, was not significant.

Finally, in order to more firmly establish the teachers' perceptions of physics, all non-"physics" responses were classified as "other" in a 2 by 2 contingency table and chi-square was computed once again. The null hypothesis of independence again failed to be rejected. However, the teachers saying physics was their subject of choice were less likely (73% vs. 81%) to anticipate adoption of the new physics course. Perhaps teachers who preferred to teach physics were more reluctant to undertake the responsibility of teaching a multidisciplinary course than teachers who, by their non-"physics" responses to this item coupled with their presence at a physics institute, were exhibiting a multidisciplinary attitude.

Teacher Perceptions of the Adoption Process

Twenty-four semantic differential antonym pairs relating to the process of adopting a new physics course (see p.SD-7, Appendix A) were examined. Sixteen of the items were monotonically related (see Table 27) to the expectation of adoption at the 0.05 level of confidence; two other items missed the 0.05 cut-off by a narrow margin; and one was non-monotonically related. The large number of significant relationships and the large gammas (i.e. proportionate reductions in error of predicting relative expectation of adoption given the levels of the independent variables) make these variables particularly interesting. The results of the individual computations are presented in Tables 28 through 46.

Table 27
Significance levels of interactions between teachers' perceptions of the Process of adopting a new Physics course and expectation of adoption of Project Physics (N=304-315). (Summary of Tables 28-46)

	Test for relationship	Test for monotonic relationship
	p	p
Adjective antonym pair	X^2_2 df	S
Important-Unimportant	0.001	0.00024
Productive-Unproductive	0.001	0.00068
Democratic-Authoritarian	NS	NS
Friend-Enemy	0.083	0.043
Wise-Foolish	0.001	0.0004
Comforting-Threatening	0.049	0.015
Helpful-Obstructive	0.0001	0.00006
Kind-Cruel	0.068	0.056
Cooperative-Uncooperative	0.016	0.0086
Predictable-Unpredictable	NS	NS
Simple-Complex	NS	NS
Reliable-Unreliable	0.096	0.028
Easy-Difficult	NS	NS
Saving-Wasteful	NS	NS
Trustworthy-Untrustworthy	0.002	NS
Sociable-Unsociable	0.007*	0.007
Dominant-Passive	0.017*	0.017
Cheerful-Solemn	0.056*	0.056
Dependable-Undependable	0.071	0.025
Interesting-Dull	0.037	0.0014
Strong-Weak	0.055	0.018
Sympathetic-Unsympathetic	0.053	0.017
Supporting-Undermining	0.039	0.025
Professional-Unprofessional	0.081	0.030

* Chi-squared computation with 1 degree of freedom rather than two as indicated in the column heading.

Table 28
Teacher perception of the <u>importance</u> of the process of "Adopting a New Physics Course" <u>vs</u>. expectation of adoption of Project Physics

	Importance Low	Medium	High	
Early Adoption	66.0% 66 (76.6)	75.5% 74 (75.3)	87.2% 102 (90.1)	242
Deferred Adoption	34.0% 34 (23.4)	24.5% 24 (22.7)	12.8% 15 (26.9)	73
	100	98	117	315

S=4748 SD=1283 p=0.00024 gamma=0.392

Table 29
Teacher perception of the <u>productivity</u> of the process of "Adopting a New Physics Course" <u>vs</u>. expectation of adoption of Project Physics

	Productivity Low	Medium	High	
Early Adoption	69.6% 78 (86.1)	72.4% 76 (80.8)	90.5% 86 (73.1)	240
Deferred Adoption	30.4% 34 (25.9)	27.6% 29 (24.2)	9.5% 9 (21.9)	72
	112	105	95	312

S=4354 SD=1262 p=0.0007 gamma=0.374

Table 30
Teacher perception of the process of "Adopting a New Physics Course" as friend(ly) vs. expectation of Adopting Project Physics

	Friend(liness) Low	Medium	High	
Early Adoption	72.5% 95 (110.5)	72.4% 42 (44.5)	83.6% 97 (89.0)	234
Deferred Adoption	27.5% 36 (30.5)	27.6% 16 (13.5)	16.4% 19 (27.0)	71
	131	58	116	305

S=2433 SD=1207 p=0.043 gamma=0.228

Table 31
Teacher perception of the wisdom of the process of "Adopting a New Physics Course" vs. expectation of adoption of Project Physics

	Wisdom Low	Medium	High	
Early Adoption	67.6% 92 (104.8)	81.9% 77 (72.6)	88.2% 67 (58.6)	236
Deferred Adoption	32.4% 44 (31.2)	18.1% 17 (21.4)	11.8% 9 (17.4)	70
	136	94	76	306

S=4390 SD=1212 p=0.0004 gamma=0.416

Table 32
Teacher perception of the process of "Adopting a New Physics Course" as comforting vs. expectation of adoption of Project Physics

	Comforting: Low	Medium	High	
Early Adoption	70.3% 97 (105.9)	80.0% 48 (45.9)	83.2% 89 (82.2)	234
Deferred Adoption	29.7% 41 (32.1)	20.0% 12 (14.1)	16.8% 18 (24.8)	71
	138	60	107	305

S=2911 SD=1205 p=0.015 gamma=0.278

Table 33
Teacher perception of the helpfulness of the process of "Adopting a New Physics Course" vs. expectation of adoption of Project Physics

	Helpfulness: Low	Medium	High	
Early Adoption	64.5% 71 (84.6%)	79.8% 91 (87.7)	88.6% 78 (67.7)	240
Deferred Adoption	35.5% 39 (25.4)	20.2% 23 (26.3)	11.4% 10 (20.3)	72
	110	114	88	312

S=5132 SD=1262 p=0.00006 gamma=0.441

Table 34
Teacher perception of the process of "Adopting a New Physics Course" as kind vs. expectation of adoption of Project Physics

	Kind(ness) Low	Medium	High	
Early Adoption	73.5% 108 (112.6)	71.4% 40 (43.2)	84.6% 88 (80.2)	236
Deferred Adoption	26.5% 39 (34.4)	28.6% 16 (12.8)	15.4% 16 (23.8)	71
	147	56	104	307

S=2304 SD=1205 p=0.056 gamma=0.220

Table 35
Teacher perception of the process of "Adopting a New Physics Course" as Cooperative vs. expectation of adoption of Project Physics

	Cooperative(ness) Low	Medium	High	
Early Adoption	71.2% 89 (95.9)	71.2% 42 (45.5)	85.4% 105 (94.6)	236
Deferred Adoption	28.8% 36 (29.1)	28.8% 17 (13.5)	14.6% 18 (28.4)	71
	125	59	123	307

S=3206 SD=1216 p=0.009 gamma=0.293

Table 36
Teacher perception of the reliability of the process of "Adopting a New Physics Course" vs. expectation of adoption of Project Physics

	Reliability Low	Medium	High	
Early Adoption	72.4% 105 (112.2)	77.1% 54 (53.9)	84.4% 81 (73.9)	240
Deferred Adoption	27.6% 40 (32.8)	22.9% 16 (16.1)	15.6% 15 (22.1)	71
	145	70	96	311

S=2711 SD=1232 p=0.03 gamma=0.244

Table 37
Teacher perception of the trustworthiness of the process of "Adopting a New Physics Course" vs. expectation of adoption of Project Physics

	Trustworthiness Low	Medium	High	
Early Adoption	70.3% 121 (134.2)	92.3% 48 (40.2)	81.9% 68 (52.6)	237
Deferred Adoption	29.7% 51 (37.8)	7.7% 4 (11.8)	18.1% 15 (30.4)	70
	172	52	83	307

$X^2_{2\ df}=12.38$ p=0.002 Tau-b=0.148

Table 38

Teacher perception of the process of "Adopting a New Physics Course" as sociable vs. expectation of adoption of Project Physics*

	Sociable Low	Sociable High	
Early Adoption	71.9% 138 (148.2)	86.0% 98 (87.8)	236
Deferred Adoption	28.1% 54 (43.8)	14.0% 16 (26.2)	70
	192	114	306

$X^2_{1\ df}=7.27$ p=0.007 gamma=0.411

* The teacher replies on the independent variable were dichotomized because the distribution could not be conveniently trichotomized.

Table 39

Teacher perception of the process of "Adopting a New Physics Course" as dominant vs. expectation of adoption of Project Physics*

	Dominance Low	Dominance High	
Early Adoption	72.5% 140 (149.0)	85.1% 97 (88.0)	237
Deferred Adoption	27.5% 53 (44.0)	14.9% 17 (26.0)	70
	193	114	307

$X^2_{1\ df}=5.72$ p=0.017 gamma = 0.367

* The teacher replies on the independent variable were dichotomized because the distribution could not be conveniently trichotomized.

Table 40
Teacher perception of the cheerfulness of the process of "Adopting a New Physics Course" vs. expectation of adoption of Project Physics*

	Cheerfulness: Low	High	
Early Adoption	72.3% 115 (122.4)	82.2% 120 (112.6)	235
Deferred Adoption	27.7% 44 (36.6)	17.8% 26 (33.4)	70
	159	146	305

$X^2_{1\ df}=3.65$ p=0.056 gamma=0.277

* The teacher replies on the independent variable were dichotomized because the distribution could not be conveniently trichotomized.

Table 41
Teacher perception of the dependability of the process of "Adopting a New Physics Course" vs. expectation of adoption of Project Physics

	Dependability: Low	Medium	High	
Early Adoption	71.4% 105 (113.4)	81.2% 56 (53.2)	83.3% 75 (69.4)	236
Deferred Adoption	28.6% 42 (33.6)	18.8% 13 (15.8)	16.7% 15 (20.6)	70
	147	69	90	306

S=2697 SD=1202 p=0.025 gamma=0.263

Table 42
Teacher perception of the process of "Adopting a New Physics Course" as <u>interesting</u> <u>vs</u>. expectation of adoption of Project Physics

	Interestingness			
	Low	Medium	High	
Early Adoption	69.4% 77 (85.4)	78.6% 81 (79.2)	84.4% 76 (69.4)	234
Deferred Adoption	30.6% 34 (25.6)	21.4% 22 (23.8)	15.6% 14 (20.6)	70
	111	103	90	304

S=3874 SD=1215 p=0.0014 gamma=0.284

Table 43
Teacher perception of the <u>strength</u> of the process of "Adopting a New Physics Course" <u>vs</u>. expectation of adoption of Project Physics

	Strength			
	Low	Medium	High	
Early Adoption	70.9% 100 (108.6)	81.0% 51 (48.6)	83.3% 85 (78.8)	236
Deferred Adoption	29.1% 41 (32.4)	19.0% 12 (14.4)	16.7% 17 (23.2)	70
	141	63	102	306

S=2829 SD=1204 p=0.02 gamma=0.273

Table 44
Teacher perception of the process of "Adopting a New Physics Course" as sympathetic vs. expectation of adoption of Project Physics

	Sympathetic Low	Medium	High	
Early Adoption	71.6% 116 (124.8)	81.6% 31 (29.3)	83.8% 88 (80.9)	235
Deferred Adoption	28.4% 46 (37.2)	18.4% 7 (8.7)	16.2% 17 (24.1)	70
	162	38	105	305

S=2779 SD=1163 p=0.02 gamma=0.296

Table 45
Teacher perception of the process of "Adopting a New Physics Course" as supporting vs. expectation of adoption of Project Physics

	Supporting Low	Medium	High	
Early Adoption	68.6% 70 (78.9)	81.4% 114 (108.0)	81.8% 54 (51.1)	238
Deferred Adoption	31.4% 32 (23.1)	18.6% 26 (32.0)	18.2% 12 (14.9)	70
	102	140	66	308

S=2752 SD=1223 p=0.025 gamma=0.255

Table 46
Teacher perception of the process of "Adopting a New Physics Course" as professional vs. expectation of adoption of Project Physics

	Professional Low	Medium	High	
Early Adoption	72.0% 85 (91.0)	75.6% 68 (69.4)	84.7% 83 (75.6)	236
Deferred Adoption	28.0% 33 (27.0)	24.4% 22 (20.6)	15.3% 15 (22.4)	70
	118	90	98	306

S=2644 SD=1223 p=0.03 gamma=0.241

Teachers' Perceptions of Project Physics

Six questionnaire items evaluated the teachers' perceptions of Project Physics. Two of the six measures were monotonically related to the expectation of adoption of the new course: the teacher's perceived difficulty of teaching Physics in the long run; and the number of Project Physics summer institute applications submitted by the teacher (for the year 1970).

Perceived Difficulty in Teaching Project Physics

Both Barnett[19] and Rogers[20] have observed that the adoption of an innovation is affected by the difficulty the potential adopter perceives in the implementation process. Barnett, for example, says "Activities that require concentrated and prolonged effort to master them or to gain an understanding of them are at a disadvantage compared with some alternative that does not."[21] The teachers were asked how difficult they believed they would find the new course to teach <u>in the long run</u> compared to the physics course they had been teaching (see item 56, Appendix A). A monotonic relationship, significant at the 0.006 level, indicated that teachers who believed the course would be less difficult to teach in the long run were significantly more likely to anticipate an early adoption than teachers who believed the course would not be easier to teach (see Table 47).

Table 47
Teacher perception of the difficulty of teaching Project Physics in the long run vs. expectation of adoption of Project Physics

	Difficulty			
	More	Same	Less	
Early Adoption	72.3% 34 (35.8)	70.7% 128 (138)	87.0% 94 (82.2)	256
Deferred Adoption	27.7% 13 (11.2)	29.3% 53 (43)	13.0% 14 (25.8)	80
	47	181	108	336

S=3798 SD=1360 p=0.006 gamma=0.318

On the other hand, when the teachers were asked how difficult they believed their <u>first year</u> of teaching the new course would be compared with the course they had been teaching, (see item 55, Appendix A), no significant relationship with expectation of adoption was found. Apparently, teachers are willing to accept a change which, while it may present difficulties initially, promises to simplify their teaching responsibilities in the long run.

Teachers' Motivation to Adopt Project Physics

The teachers attending the 14 summer institutes examined in this study applied to an average of two institutes each. We assumed that teachers who were highly motivated to adopt the new course would apply to more institutes in order to increase their chances of being accepted. Therefore, the teachers were asked how many such institute applications they made for the summer of 1970 (see part 3, item 51, Appendix A). Their responses were trichotomized as shown in Table 48 and were tested for a monotonic relationship with the expectation of adoption of the new course. The test of the null hypothesis of no monotonic relationship was rejected (p less than 0.02). Teachers who anticipated an early adoption tended to submit more applications (i.e. were more highly motivated to adopt Project Physics).

Table 48
Teachers' numbers of Project Physics summer institute applications in 1970 *vs*.expectation of adoption of Project Physics

	Number of Applications			
	1	2-3	4 or more	
Early Adoption	71.7% 104 (109.8)	77.9% 74 (72)	80.8% 63 (59.2)	241
Deferred Adoption	28.3% 41 (35.2)	22.1% 21 (23)	19.2% 15 (18.8)	77
	145	95	78	318

S=3085 SD=1330 p=0.02 gamma=0.177

Other Perceptions of Project Physics

Three other items, each thought to be measuring a dimension of the teachers' perceptions of Project Physics, failed to be significantly related to the teachers' expectations of adoption: the length of time the teacher had known of Project Physics; the medium through which the teacher first heard of Project Physics; and whether or not the teacher knew the general nature of Project Physics before he attended the summer institute (see items 32,33, and 52(g) of Appendix A).

The Relationship of Administrator Variables to Expected Adoption Status

The administrators attending the conferences were asked (Appendix B) most of the questions asked of the teachers, and the data were analyzed in a similar manner. Only the seventy-two administrators associated with a teacher enrolled in a summer institute were included in the analysis because there would be no dependent variable -- teacher expectation of adoption of Project Physics -- for the administrators attending independently.[22]

The administrator characteristics examined were, for the most part, the same as those for the teachers. The number of variables that appeared to be significantly related ($p < 0.05$) to the anticipated adoption status did not, however, exceed the number that one would expect due to random variation in the data. Thus, no administrator characteristics were identified as positively related to the expectation of adoption of Project Physics. This finding is consistent with the result of the small group discussions described in the second chapter of this report; there we concluded that the teacher's effort to initiate action was the sine qua non in adopting a new physics course.

The Relationship of School Characteristics to Expected Adoption Status

The school characteristics examined in this study are classified as "general" and "science related." General school characteristics include such variables as school size, building age, the geographic region of the country, and the nature of the area served by the school: urban, suburban, town, and rural. The science-related school characteristics include the school's history of adopting new science courses other than Project Physics, and the recency of renovation of the science facility.

General School Characteristics

Thirteen variables were considered to be general school characteristics. Seven of the thirteen variables were suggested by research from related fields and, of the seven, three were identified as significantly related to expectation of adoption of Project Physics at the 0.05 level of confidence. Six additional variables were examined, but none was significantly related to the teachers' expectations of adoption of Project Physics.

The School's History of Adopting New Courses in all Subject Areas

It was assumed that schools that had established a pattern of adopting new courses would be more likely to adopt another new course such as Project Physics than would schools that were not "in the habit" of adopting new courses. The reasoning was simply that whatever forces had stimulated or mitigated against course adoption in the past would probably still be acting. Leighton and Smith, however, in investigating social changes saw an upper limit to this and stated that

> "...a community that is undergoing change at a relatively slow rate and to a moderate degree may be much better able to tolerate an innovation than may another community which is already changing both rapidly and extensively, and which is consequently suffering from marked disturbances in its functional equilibrium.[23]

Thus we expected to find a non-monotonic relationship between the expectation of adoption of Project Physics and the number of new courses (in all subject areas) that the school had recently adopted -- with the adoption expectation being highest for schools in the middle range of recent new course adoptions. The teachers were asked (Item 29, Appendix A) to list as many as they could of the new courses adopted in their schools during the past five years. Table 49 summarizes their responses.

The relationship was, however, monotonic. (See Table 50) The expectation of adoption of Project Physics continued to increase with the total number of courses that had been recently adopted. This result is contrary to the conjecture of Leighton and Smith but it simply may mean that few schools reach such a precipitate rate of change that its impeding effect on further change is noticeable.

Table 49
Numbers of new courses (all subjects) adopted by 292 schools during the past five years as reported by physics teachers

Number of courses	Number of schools	%
0-1	54	18.5
2-4	149	51.0
5 or more	89	30.5
	292	100.0

Mean number of adoptions / school = 3

Table 50
The number of new courses (all subject areas) adopted by 292 schools during the preceding five years vs. expectation of adoption of Project Physics

	Number of New Courses 0-1	2-4	5 or more	
Early Adoption	64.8% 35 (41.1)	75.2% 112 (113.5)	84.3% 75 (67.4)	222
Deferred Adoption	35.2% 19 (12.9)	24.8% 37 (35.5)	15.7% 14 (21.6)	70
	54	149	89	292

S=4147 SD=1130 p=0.0002 gamma=0.307

The Region of the Country

A study by Cocking[24] of the adoption of seven educational ideas by 1200 widely spread urban schools revealed no significant regional differences. The teachers in this study were asked to indicate on a checklist the region of the country in which they taught (Item 61, Appendix A). Chi-square analysis of the data (see Table 51) revealed a significant relationship at the 0.002 level of confidence. The expectation of an early adoption was greatest in the West (87%), South (83%), and Midwest (83%) and was least in the Southwest (55%) and Middle Atlantic States (63%). A follow-up study of this variable, however, in terms of actual adoption of Project Physics revealed no significant difference. The teachers in the West, South, Midwest, and Southeast all anticipated a markedly higher level of adoption than actually occurred according to the follow-up study.

Nature of the Area Served by the School

Cocking[25] concluded in 1957 that metropolitan schools were more innovative than rural schools. Also, Redfield[26] and Foster[27] (in their sociological studies of primitive cultures) observed that change tends to move from the city to rural areas because innovations from the city were prestigious. Foster[28] explained the underlying cause of the movement from city to country in terms of "a nearly universal desire to approximate in some degree the behavioral patterns of the upper classes." Although Cocking found metropolitan schools to be more innovative, in the 13 years since Cocking's study, cities have been replaced by the suburbs as high prestige areas. Therefore we expected to find innovations occurring first in the suburbs.

Table 51

Region of the Country vs. expectation of adopting Project Physics (N=341)

	New Eng.	Mid Atl.	S.E.	South	S.W.	West	N.W.	Mid-west	
Early Adoption	76.9% 20 (19.8)	62.7% 32 (38.7)	73.9% 17 (17.5)	83.3% 25 (22.8)	54.8% 23 (32.0)	87.0% 40 (35.0)	80.0% 8 (7.6)	83.2% 94 (86.6)	259
Deferred Adoption	23.1% 6 (6.2)	37.3% 19 (12.3)	26.1% 6 (5.5)	16.7% 5 (7.8)	45.2% 19 (10.0)	13.0% 6 (11.0)	20.0% 2 (2.4)	16.8% 19 (26.4)	82
	26	51	23	30	42	46	10	113	341

$X^2_{7\ df}=22.53$ SD=0.002 Tau-b=0.122

The teachers were asked (Item 25, Appendix A) the nature of the area their schools served. Table 52 summarizes the results of the chi-square computation which indicated a significant relationship between the nature of the area served and the expectation of adoption of Project Physics. In agreement with Foster, we found that the expectation of adoption was greatest in the more prestigious areas: suburban schools (82%), followed by rural schools (79%), town schools (71%) and finally by urban schools (65%).

Table 52
The nature of the area served by 310 schools *vs.* expectation of adoption of Project Physics

	Nature of Area				
	Urban	Suburban	Town	Rural	
Early Adoption	64.6% 51 (59.3)	82.1% 101 (92.4)	70.6% 36 (38.4)	78.9% 45 (42.9)	233
Deferred Adoption	35.4% 28 (19.7)	17.9% 22 (30.6)	29.4% 15 (12.6)	21.1% 12 (14.1)	77
	79	123	51	57	310

$X^2_{3\ df}=8.95$ $p=0.03$ Tau-b= -0.076

The Incidence of Organizational Crisis

Shephard[29] and Rogers[30] have both observed that innovations are most readily adopted and implemented at times of organizational crisis. Accordingly, we expected that schools with a higher incidence of recent crises such as teacher strikes, student boycotts, and threatened losses of accreditation (Item 28, Appendix A), might have greater expectations of adoption of Project Physics than schools with fewer such crises. Although a monotonic trend in the expected direction was detected, the relationship was not significant (p=0.25).

The School's per pupil Expenditure

Mort[31] and Rogers[32] have reported findings that the adoption of educational innovations is related to the school's level of expenditure. Accordingly, a relationship was sought between the school's per pupil expenditure (Item 46, of Appendix B) and the expectation of adoption of Project Physics. No relationship, however, was found.

Only 45 of the administrators (who included some guidance counselors and curriculum coordinators as well as principals and superintendents) were able to provide an estimate of their schools' per pupil expenditures. Because the sample was small, the requirement for the rejection of the null hypothesis was stringent. A weak trend in the data, however, opposed the conclusions of Mort and Rogers; the expectation of adoption of Project Physics was somewhat greater in schools with smaller expenditures per pupil. (Carlson[33] reported a similar non-significant negative relationship between adoption and per pupil expenditures in his Allegheny County study.)

Size of School

Carlson[34] found that school size correlated positively with the rate of adoption of innovations. We, however, did not find the expectation of adoption of Project Physics to be greater in larger schools. Because of the possibility of confounding introduced by the fact that urban schools (which it will be recalled have the lowest expectation of adoption) also tend to be very large, the relationship of school size to adoption expectation was examined separately for schools serving different kinds of areas. Once again, no relationship could be found linking school size to the teachers' expectations of adoption -- regardless of the areas served by the schools.

Age of the School Building

Margaret Mead has observed that

> "In any attempt to use the old ways of behavior to facilitate change, it is,..., important to keep in mind that sometimes a change will be accepted more easily if it is in a new context. So a new kind of organization may be perceived as more appropriate for a new kind of activity -- so that people will accept a factory and a union together where either one alone might be rejected. Paper cups may be accepted more readily if an unfamiliar beverage is served in them."[35]

Consistent with this thinking we suspected that schools with a new physical plant would be more likely to adopt new courses of study such as Project Physics.

The teachers were asked when their school building was erected (Item 23, Appendix A) but no relationship was found with the expectation of adoption of Project Physics. A later section will investigate the relationship of newness of the <u>science facility</u> to the anticipation of adoption of Project Physics.

Other General School Variables

Six other general school variables were examined: the percent of the total school budget spent on central administration; the "type" of school -- general/technical/college preparatory, public/independent/church affiliated, and boarding/non-boarding; the distribution of the student body by sex; and the size of the school system. Most of these variables were investigated without a theoretical reason.

David K. Cohen[36] of Harvard's Graduate School of Education suggested that school administrations might, over time, tend to increase the fraction of the total school budget spent on central administration. If one assumes that such an increase is accompanied by increased bureaucracy and by increased resistance to change, then it may also be accompanied by a decreased expectation of the adoption of new courses such as Project Physics. The administrators were asked to estimate the fraction of the school's budget going into central administration (Item 48, Appendix B). No significant relationship was detected, but the large variance in the responses to the questionnaire item suggests that the questionnaire item did not have the same meaning for all respondents. The mean expenditure was 5.6% but the answers ranged from 1% to 30%.

Finally, the size of the school system was investigated (Items 17 and 18, Appendix B) with the expectation that larger school systems might more readily adopt innovations because, being larger, they could "hedge their bets" by adopting new programs on a pilot basis before committing a substantial portion of their budgets to them. In small schools, a pilot program in physics might be tantamount to total adoption with a concommitant relatively large expenditure of funds. Once again, however, no differences in expectation of adoption for different sized school systems could be detected.

Science related School Characteristics

Two variables specifically related to schools' science programs were examined: the recency of renovation of the school's science facility, and the school's recent history of adopting new science courses (other than Project Physics). Both of these variables were significantly related to the expectation of adoption of Project Physics.

Recency of Renovation of the School's Science Facility

The teachers were asked the dates of the last major renovation or remodeling of their schools' science facilities (Item 24, Appendix A). Recall that Margaret Mead suggested[37] that changes occur more readily in a new setting. Thus we expected that newly remodeled science departments would have a greater expectation of adopting Project Physics. Although a significant relationship was found relating the recency of science department renovation with expectation of adoption, it did not confirm Mead's hypothesis. Table 53 presents the results of the chi-square computation, which indicated that the greatest expectation of early adoption (81%) occurred among those schools that had never undertaken a major science facility renovation.

Table 53
Recency of remodeling of the Science department facility *vs.* expectation of adopting Project Physics

	Date of renovation				
	Never	Before '56	56-55	After '65	
Early Adoption	81.5% 22 (20.4)	46.7% 7 (11.3)	80.7% 71 (66.3)	74.0% 77 (79.0)	177
Deferred Adoption	18.5% 5 (6.6)	53.3% 8 (3.7)	19.3% 17 (21.7)	26.0% 27 (25.0)	57
	27	15	88	104	234

$X^2_{3\ df}=8.69$ $p=0.034$ Tau-b=0.008

The relationship is not simple and one wonders if it is confounded. The "Never remodeled" group does not contain schools built recently, however, so that cannot account for the very high proportion of these schools that have teachers expecting an early adoption. The low value for Tau-b indicates that the relationship provides essentially no improvement in one's ability to predict the dependent variable given the independent variable.

The School's History of Adopting New Science Courses

A monotonic relationship has already been identified (Table 50, p.82)between the school's recent history of adopting new courses of instruction and the expectation of adopting Project Physics. When the school's history of adopting new science courses is considered, the relationship is even stronger.

The teachers indicated whether and when each of six of the more commonly used new science programs was first used in their schools (Item 30, Appendix A). A strong monotonic relationship was found between the number of the new science courses the schools had adopted and their teachers' expectations of adopting Project Physics (see Table 54).

The earliness of adoption of only two of the six courses -- CHEMStudy chemistry and BSCS biology -- was monotonically related to the expectation of adoption of Project Physics (see Tables 55 and 56). Adoption of the other four courses -- PSSC physics, CBA chemistry, Introductory Physical Science, and ESCP science -- was not related to the expectation of adoption of Project Physics, although PSSC physics was very near to the significance cut-off of 0.05 (see Table 57).

Table 54
The number of new science courses adopted by 290 schools in recent years *vs.* expectation of adopting Project Physics

	Number of new science courses				
	0	1-2	3-4	5-6	
Early Adoption	35.3% 6 (13.4)	76.3% 87 (90.0)	84.2% 101 (94.8)	89.7% 35 (30.8)	229
Deferred Adoption	64.7% 11 (3.6)	23.7% 27 (24.0)	15.8% 19 (25.2)	10.3% 4 (8.2)	61
	17	114	120	39	290

S=4085 SD=1,055 p=0.00012 gamma=0.430

Table 55
Recency of adopting CHEMS chemistry *vs.* expectation of adopting Project Physics

	Date CHEMStudy first used			
	Before 1966	1966 to 1970	Never used	
Early Adoption	87.4% 76 (68.1)	86.4% 57 (51.7)	67.0% 77 (90.2)	210
Deferred Adoption	12.6% 11 (18.9)	13.6% 9 (14.3)	33.0% 38 (24.8)	58
	87	66	115	268

S=3571 SD=971 p=0.0002 gamma=0.452

Table 56
Recency of adopting BSCS biology *vs.* expectation of adopting Project Physics

	Date BSCS biology first used			
	Before 1966	1966 to 1970	Never used	
Early Adoption	86.3% 82 (74.6)	83.6% 61 (57.2)	66.7% 64 (75.2)	207
Deferred Adoption	13.7% 13 (20.4)	16.4% 12 (15.8)	33.3% 32 (20.8)	57
	95	73	96	264

S=3167 SD=962 p=0.0008 gamma=0.398

Table 57
Recency of adopting PSSC physics *vs.* expectation of adopting Project Physics

	Date PSSC physics first used			
	Before 1966	1966 to 1970	Never used	
Early Adoption	84.2% 96 (89.0)	76.9% 30 (30.4)	73.0% 89 (95.6)	215
Deferred Adoption	15.8% 18 (25.0)	23.1% 9 (8.6)	27.0% 33 (26.4)	60
	114	39	122	275

S=2059 SD=1133 p=0.054 gamma=0.261

Each of the three most heavily adopted science courses -- BSCS, CHEMS, and PSSC -- were being used in more than one-half of the schools represented by teachers responding to this item. The fact that the history of adopting CHEMS and BSCS was so strongly related to Project Physics adoption expectation suggests that the effect of the history of PSSC adoption to Project Physics adoption may be confounded. Some confounding may occur because the intended student populations and the objectives of the PSSC and Project Physics courses differ. Innovativeness in adopting PSSC physics would not necessarily carry over to innovativeness in adopting Project Physics if teachers perceived basic ideological differences in the two courses.

It appears, then, that knowledge of the number of new science courses recently adopted by a school would appreciably improve one's ability to predict the expectation of adoption of Project Physics, but one could do as well (if not somewhat better) by knowing only whether CHEMStudy or BSCS had been adopted in the school.

The Relationship of Summer Institute Variables to Expected Adoption Status

Five variables related to the summer institutes that the teachers were attending were examined: 1) the fraction of the institute that participants perceived as being devoted to the philosophy and methodology of Project Physics; 2) the number of participants in the summer institute; 3) the starting date of the summer institute; 4) the length of the summer institute; and 5) whether the institute was conducted by a science department or a department of science education. None of these variables was significantly related to the teachers' expectations of adopting Project Physics.

The institute the teachers was attending was significantly related (p less than 0.00001) to the teachers' expectations of adoption. However, the relationship is seriously confounded by the fact that some institutes considered only applicants who provided some evidence (e.g. a letter from the principal) that Project Physics would soon be adopted. Therefore, detailed results are not reported here lest they be misinterpreted. Furthermore, the companion study referred to earlier[38] revealed that in terms of actual adoption, there were no significant differences in adoption by summer institute.

Conclusion

We have enumerated more than 50 teacher, administrator, and school characteristics that are statistically related to the expectation of adoption of Project Physics by physics teachers attending Project Physics summer institutes. The strengths of the relationships (as measured by gamma or Tau-b) vary immensely in terms of predicting the dependent variable from the independent variable; in some cases the likelihood of making errors in prediction can be reduced by as much as 80%; in others, essentially no reduction at all is possible.

Probably there is considerable redundancy in the large number of significant relationships identified. That is, several variables may be measuring much the same thing, with a single underlying factor -- the element common to a group of intercorrelated variables -- being the really important, perhaps not directly tested, variable. The factor analysis which is described in the next chapter condenses the numerous relationships discussed in this chapter into a few groups of intercorrelated variables.

Chapter III
Footnotes

1 This report does not include a discussion of changes in perceptions of the decision-making process experienced by the participants of the conferences, because such changes are not directly relevant to the research question being examined here. A short paper, to be prepared for later publication, will address the question of the kinds of changes in perceptions which teachers and administrators undergo during such conferences.

2 William W. Cooley and Leo E. Klopfer, "Test on Understanding Science" (Princeton, N.J.: Educational Testing Service, 1961).

3 Marshall D. Sahlins and Elman R. Service, eds., Evolution and Culture (Ann Arbor: University of Michigan Press, 1960),pp.104-105.

4 Everett M. Rogers, Diffusion of Innovations (New York: The Free Press, 1967),p.35.

5 Richard O. Carlson, Adoption of Educational Innovations (Eugene, Oregon: The Center for the Advanced Study of Educational Administration, The University of Oregon,1965),p.65.

6 Carlson, ibid.

7 E.R.Chadwick, "Communal Development in Udi Division," Overseas Education,19:627-644, 1948, referenced in Gilbert Kushner, et.al., What Accounts for Sociocultural Change? A Propositional Inventory, (Chapel Hill: Institute for Research in Social Science, University of North Carolina,1962).

8 George M. Foster, _Problems in Intercultural Health Programs_ (New York: Social Science Research Council, 1958) Pamphlet #12.

9 Rogers, _ibid_., p.241.

10 Margaret Mead, ed., _Cultural Patterns and Technical Change_ (Paris: United Nations Educational, Scientific, and Cultural Organization, 1953), p.195.

11 Frank W. Lutz and Laurence Iannaccone, _Understanding Educational Organizations: A Field Study Approach_ (Columbus, Ohio: Chas.E.Merrill Publishing Co., 1969), p.22.

12 Carlson, _ibid_. pp.49-65.

13 A superintendent was said by Carlson to have conflicted performance standards when the person perceived by the superintendent as _best_ able to evaluate his professional performance differed from the person whose evaluation he considered to be _most important_.

14 Cooley and Klopfer, _ibid_.

15 See Note 13, p.96 for a definition of "conflicted."

16 Here one must be careful not to confound the recency of the teacher's last course for credit with the recency of the teacher's acquiring his highest degree, or with his age. While almost 70% of the teachers responding to the item had taken a course since 1968, less than 49% had earned their highest degree during that period. Furthermore, recall that there was no significant relationship between the recency of the teacher's highest degree and the teacher's expectation of adopting Project Physics.

Finally, a factor analysis, described in a later section of this report, does not show a strong relationship between recency of college courses and teacher age. A companion study by one of the authors of this report gave a similar result (Yegge, ibid.pp.117-120).

17 Yegge, ibid. p.161.

18 Ibid, pp.161-162.

19 Homer G. Barnett, Innovation: The Basis of Cultural Change (New York: McGraw-Hill Book Co.,Inc.,1953),p.369.

20 Rogers, ibid. p.130.

21 Barnett, ibid.

22 Recall that there was a strong correspondence between the teachers' and the administrators' expectations of adoption; therefore we did not believe that it was necessary to change the computation of the dependent variable for the analysis of the administrator data.

23 Alexander H. Leighton and Robert J. Smith, "A Comparative Study of Social and Cultural Change," Proceedings of the American Philosophical Society, 99: 82-83,1955.

24 Walter Cocking, The Regional Introduction of Educational Practices in Urban School Systems in the United States (New York: Teachers College, Columbia University, Institute of Administrative Research, 1957) Study 6.

25 Cocking, ibid.

26 Robert Redfield, The Primitive World and its Transformations (Ithica, New York: Cornell University Press,1953),pp.37-38.

27 Foster, _ibid_. p.13.

28 _Ibid_.p.36.

29 Herbert A. Shephard, "Innovation-Resisting and Innovation-Producing Organizations," in _The Planning of Change_ (2nd ed.), ed. by Warren G. Bennis, Kenneth D. Benne, and Robert Chin (New York: Holt, Rinehart and Winston, Inc.,1969),p.520ff.

30 Rogers, _ibid_. p.125.

31 Paul R. Mort and Francis G. Cornell, _American Schools in Transition: How Our Schools Adapt Their Practices to Changing Needs_ (New York. Teachers College, Columbia University,1941),p.194.

32 Rogers, _ibid_. p.175.

33 Carlson, _ibid_. p.49.

34 _Ibid_. pp.49ff.

35 Mead, _ibid_. p.300.

36 David K. Cohen, personal communication, May, 1970.

37 Mead, _ibid_.

38 Yegge, _ibid_. p.200.

CHAPTER IV

FACTOR ANALYSIS OF SIGNIFICANTLY RELATED INDEPENDENT VARIABLES

The cross-tabulations described in the preceding chapter identified more than fifty variables as significantly related to physics teachers' expectations of adopting Project Physics after attending a summer institute. Considered individually, the array of relationships is confusing. Of course, there are not fifty or more processes functioning simultaneously, each independently having a strong relationship with teachers' expectations of adoption. Rather, within the array there are probably groups of relationships which cluster together -- i.e. which are strongly intercorrelated. Principal components factor analysis is a useful way of identifying such groups of interrelated variables.

Factor analysis assigns a "loading" value to each of the independent variables for each cluster of intercorrelated variables identified. A factor loading is analagous to the correlation coefficient r; it expresses the correlation between the test item and the cluster of intercorrelated variables. Kerlinger suggests that a loading of more than 0.4 is conservative as a requirement for inclusion of an item in a factor although for large samples (such as that in this study) loadings of less than half that signify intercorrelations significant at the 0.01 level.[1] A minimum loading of 0.4 was required in this study to avoid inclusion of variables of little significance within factors.

Interpretation of the common element underlying the items constituting a factor is difficult, for the process is subjective. Investigators frequently try to epitomize a factor with one or two key words which may oversimplify the meaning of the factor. Hence, the labels and interpretations attributed to factors may be less informative than direct examination of the items in the factors. In interpreting the clusters obtained in this study, therefore, reference should always be made back to the component variables.

Table 58 presents the rotated five-factor[2] matrix of 54 independent variables which, as reported in Chapter III, are all significantly related to expectations of adopting Project Physics. Variables which had not been identified as significantly related to expectation of adoption were not included in the factor analysis. The table has been arrayed so that all of the items in a cluster are displayed together (in descending order of loading value); variables which loaded significantly in two factors are starred in both entries, and the communality h^2 (sum of squares of the factor loadings) is omitted in the second entry.

The Five Factors

Factor I

The first factor accounts for 7.70/54 = 14.3% of the total variance in the matrix of

Table 58

Rotated Factor Matrix of Significant Independent Variables
(decimal points omitted)

Variable Description	Factor I	Factor Loadings I	II	III	IV	V	h^2
Semantic differential items							
Adopting a new physics course		#					
Dependable (vs. undependable)		84	03	04	04	07	71
Trustworthy (vs. untrustworthy)		79	05	12	03	06	64
Strong (vs. weak)		78	01	03	02	14	63
Sympathetic (vs. unsympathetic)		77	03	03	04	01	60
Reliable (vs. unreliable)		76	-03	13	07	10	61
Supporting (vs. undermining)		73	07	09	10	20	60
Sociable (vs. unsociable)		71	01	03	04	-01	51
Cooperative (vs. antagonistic)		71	-01	02	05	19	55
Dominant (vs. submissive)		64	04	04	01	-08	42
Comforting (vs. threatening)		63	-01	-01	11	28	48
Friend (vs. enemy)		63	05	06	00	27	47
* Professional (vs. unprofessional)		59	02	20	09	41	56
Interesting (vs. dull)		51	00	15	08	37	42
* Wise (vs. foolish)		48	01	07	10	66	68
* Helpful (vs. obstructive)		47	01	12	09	67	69
* Productive (vs. unproductive)		40	03	05	16	72	71

* Starred variables are grouped in two clusters. The communality h^2 is omitted in the second entry.
\# This symbol marks the beginning of each new cluster and indicates the axis with the largest loading values.

Table 58 (continued)

Variable Description	Loadings					
Factor II	I	II	III	IV	V	h^2
The school has a history of adopting new science courses	04	# 69	-02	01	01	48
Teacher believes department head knew general nature of course before summer	-08	63	01	17	14	46
The school was an "early adopter" of BSCS biology	09	62	01	-03	-10	40
The school was an "early adopter" of CHEMStudy chemistry	06	58	-11	05	-12	37
Teacher believes department head knew his summer institute plans before summer	-16	54	10	18	05	36
*Teacher believes several adms. knew the general nature of course before summer	-05	50	05	54	21	59
Teacher believes the department head supports his adoption request	07	46	-07	22	-05	27
The school has a history of adopting new courses in all areas	09	44	-02	-02	06	21

Table 58 (continued)

Variable Description	I	II	III	IV	V	h^2
	Loadings					
Factor III						
Semantic differential items						
Guidance counselor						
Supporting (vs. undermining)	19	00	# 80	-03	-04	67
Professional (vs. unprofessional)	17	01	77	00	05	63
Friend (vs. enemy)	15	05	74	06	08	59
Important (vs. unimportant)	-06	11	67	-04	12	48
Physics teacher						
Important (vs. unimportant)	12	-15	41	08	44	41
Factor IV						
Teacher believes several administrators support his adoption proposal	11	14	-08	# 76	-04	62
Teacher believes his superintendent supports his adoption proposal	21	-17	-08	65	04	50
Teacher believes his principal supports his adoption proposal	07	04	-02	57	14	35
*Teacher believes several adms. knew the general nature of course before summer	-05	50	05	54	21	
Teacher believes several adms. knew his summer institute plans before summer	08	31	12	53	-13	42
Teacher believes principal knew the general nature of course before summer	-05	17	10	53	21	37
Teacher believes school board member(s) support his adoption proposal	10	-12	-08	48	-11	28
Teacher believes superintendent knew the general nature of course before summer	02	-05	-07	47	18	26

Table 58 (continued)

Variable Description	I	II	III	IV	V	h^2
Factor IV						
Teacher believes guidance counselor supports his adoption proposal	06	-06	19	45	02	25
Teacher believes guidance counselor knew the general nature of course before summer	-09	22	15	44	12	29
Teacher believes curriculum coordinator knew the general nature of course before summer	-02	28	15	40	06	26
Factor V						
Semantic differential items						
Adopting a new physics course					#	
* Productive (vs. unproductive)	40	03	05	16	72	
Important (vs. unimportant)	34	-01	02	13	71	64
* Helpful (vs. obstructive)	47	01	12	09	67	
* Wise (vs. foolish)	48	01	07	10	66	
Physics teacher						
* Important (vs. unimportant)	12	-15	41	08	44	
Adopting a new physics course						
* Professional (vs. unprofessional)	59	02	20	09	41	

Columns I–V are headed "Loadings".

Table 58 (continued)

Variable Description	Loadings I	II	III	IV	V	h^2
Loaded on no factors						
Teacher is young	23	-07	-02	17	-25	15
Teacher believes curriculum coordinator knew his summer institute plans before summer	10	30	18	34	-15	27
Several others sought out the teacher's advice regarding course adoptions	06	33	-01	33	-05	22
Teacher sought out advice of several others regarding course adoptions	-02	33	00	30	10	21
Teacher is a frequent attender of professional meetings	04	12	-15	24	-06	10
Teacher recently took a course for academic credit	-12	02	11	06	-18	06
The teacher is also a department chairman	-06	-16	-04	-18	16	09
Semantic differential items						
Superintendent						
Sympathetic (vs. unsympathetic)	26	-05	33	17	-12	23
Physics						
Important (vs. unimportant)	09	-15	30	11	39	28
Democratic (vs. authoritarian)	09	-13	01	00	11	04
Cheerful (vs. solemn)	30	03	02	05	-13	11
The teacher applied for several 1970 Project Physics summer institutes	02	34	05	-06	00	13
The teacher does not perceive Project Physics as more difficult to teach in the long run	03	-02	-08	-03	29	10
The school's science facility was recently renovated	11	04	04	10	08	03
Sum of squares	7.07	3.43	2.98	3.92	3.39	21.41

54 variables.[3] All of the items in the factor come from the semantic differential item headed "Adopting a New Physics Course" which was designed to be a measure of attitude toward the <u>process</u> of adopting a new physics course. Many of the adjectives (especially those which are unique to this factor) seem to be teachers' judgments of the social acceptability of change. Many of the adjectives -- dependable, trustworthy, strong, sympathetic, reliable, supporting, sociable, cooperative, comforting, and friend(ly) -- may be a description of the teachers' perceptions of the "virtue" of the adoption process. Contrast the tone of these items with those under "Adopting a New Physics Course" that load onto Factor V -- professional, wise, helpful, productive, and important. The latter adjectives seem to be more concerned with the value or wisdom of the change process than with its social acceptability.

Factor II

The second factor accounts for 3.43/54 = 6.4% of the total variance in the matrix of 54 variables. The factor is dominated by the school's past history of course adoption (both science and non-science courses) and by the teacher's relationship with his department chairman. (About 3/4 of the sample of teachers were not department chairmen themselves.) This cluster of variables seems to be descriptive of the school's history of, and climate for, change.

Factor III

The third factor accounts for 2.98/54 = 5.5% of the total variance in the matrix of

54 variables. The factor is composed exclusively of semantic differential items and is dominated by teacher perceptions of the guidance counselor. Early adoption is favored when the teacher perceives the guidance counselor as supporting, professional, friend(ly), and important. The guidance counselor is unique among the persons examined because he is concerned chiefly with the implementation of a new course after the adoption process has been completed.

Perhaps this factor reflects the teacher's <u>estimation of his chances for a successful implementation with students after adoption</u>. Unless the teacher perceives the key person in the implementation process as supporting, professional, and friendly, his expectation of successful implementation may be slight and he may not see much benefit in vigorously pursuing a campaign leading to adoption of the new course. This cluster of variables may be the teacher's estimate of program support.

Factor IV

The fourth factor accounts for 3.92/54 = 7.3% of the total variance in the matrix of 54 variables. The cluster is characterized by the teachers' relationships to the school administrative structure (superintendents, school board members, and principals). Teachers who have prepared these "significant others" for their proposals (1) by explaining to them the general nature of the new course, and (2) by informing them of their summer institute plans, may perceive this ground work as a base of administrative support for their proposals.

Factor V

The fifth factor accounts for 3.39/54 = 6.3% of the total variance in the matrix of 54 variables. Again, all the items are semantic differential items; appear, with one exception, in other factors, and are dominated by the teachers' perceptions of the process of adopting a new physics course as productive, important, helpful, wise, and professional. Unlike the items in Factor I, which seemed to be concerned with the social acceptability of the adoption process, the items in this factor seem to emphasize the value or wisdom of the adoption process.

Some variables which did not cluster together in the factor analysis, but which might have been expected to because they are part of the folklore of education, are as interesting as those which did appear. For example, personal or professional characteristics of teachers do not group to form a factor. There are several such items:

1) The age of the teacher;
2) The teacher's frequency of attending professional meetings;
3) The recency of the teacher's latest course for academic credit;
4) Whether or not the teacher is a department chairman;
5) The teacher's motivation to adopt the new course (as measured by the number of his summer institute applications).

Although these items did not cluster together, neither did they appear in any of the other factors. These items are descriptive of teachers and the favorable aspect of each was related to an anticipation of early adoption. What seems to be important to early adoption is not so much <u>who</u> or <u>what</u> the physics teacher is, but rather <u>how</u> he is -- how he relates to others in the decision-making chain, how he perceives them, and how he perceives the adoption process.

Responses made by administrators had such low significance levels that they were not included in the factor analysis. Does this mean that, as a group, administrators do not have a consistent effect on the adoption process? Does it mean that administrator response to adoption proposals is strongly influenced by "how" the teacher is? Nothing in this study contradicts those conclusions. Furthermore, they are supported by the <u>absence of financial problems as a statistically important deterrent</u>, despite the fact that both the teachers and administrators ranked the shortage of funds <u>first</u> in a list of nine possible causes of delay of adoption. A shortage of funds may, in fact, be the most socially acceptable scapegoat to which to attribute non-adoption of innovations. This is consistent with the statement of administrators, reported in Chapter II, that, given sufficient advance notice of a desired curriculum change, the necessary funds can usually be budgeted for that purpose.

We have, then, five factors each with a unifying thread descriptive of the teacher and the school. Because the percentage of total variance explained for each of the factors is a function of both the loadings of the componenents in the factors and the numbers of items in the factors, we cannot easily arrange the factors in order of importance. Each cluster made up of statistically significant items, is in its own way important. The implications of these factors to various groups concerned about the adoption of educational innovations by schools -- teachers, school administrators, teacher educators, and summer institute directors, as well as to funders -- are discussed in Chapter VI.

Chapter IV

Footnotes

1 Fred N. Kerlinger, Foundations of Behavioral Research (New York: Holt, Rinehart and Winston, Inc., 1964), p. 654.

2 The number of factors extracted was limited by a computer stopping criterion which terminated the search for new factors after a factor was found whose communality (sum of squares of variable factor loadings) failed to exceed 10% of the total communality of the 54 variables analyzed.

3 The percentage of variance explained is related to both the loading values of the items in the clusters and to the numbers of items in the clusters. Therefore caution must be exercised in interpreting the percentages of variance explained. A large percentage of variance explained in a factor may simply reflect a preponderance of similar items in the matrix rather than "greater importance" of the factor.

CHAPTER V

SUMMARY OF A PSEUDO-REPLICATION

In a companion study,[1] the same general research question was investigated employing a sample of teachers who had attended Project Physics summer institutes but who had <u>completed</u> the adoption decision-making process. The companion study, then, was a replication of the study reported in Chapter IV except that the dependent variable in the companion study was <u>adoption</u>, rather than <u>expectation of adoption</u>, of Project Physics. Because of the great support it provides for the findings of this study, the companion study is briefly summarized in this chapter.

The companion study employed a sample of 219 physics teachers who had attended summer institutes in either 1968 or 1969. Fifty-nine percent of this group were teaching Project Physics in their schools by the second September following the summer institute and were thus considered to have adopted the course. The remaining 41% were classified, for purposes of the study, as non-adopters. Mailed questionnaire and semantic differential instruments similar to those used for this study were used to obtain data from the sample.

The analytical procedures for the companion study resembled those employed in this study: (1) Data from the sample on 45 independent variables of the original 54 that were significantly related to teachers' expectations of adoption were factor analyzed to establish the reproducibility of the intercorrelated variable clusters; (2) The significance of the differences between mean factor scores of adopters and non-adopters was determined with t-tests for each of the variable clusters to establish which of the clusters were related to the likelihood of adoption; and (3) Each of the 45 variables was tested for a monotonic relationship with adoption (a) to verify the findings of this study, and (b) to determine the direction of the relationships established between the variable clusters (found in (2) above) and adoption.

A strong correspondence was found between the variable clusters identified in the two factor analyses. No cluster in the companion study contained a variable that was not included in the corresponding cluster in this study. Because of a change in "stopping criteria" in the factor analysis, however, three new clusters were also identified in the companion study. Chiefly, these new factors were comprised of variables that had joined no cluster in this study. Thus the second (adoption) study confirmed and extended the first (adoption expectation) study.

Three of the eight clusters of variables were significantly related to the adoption of Project Physics:

(1) Factor 4 ($p=0.002$) was a cluster of five variables concerned with the teacher's perceived support to adopt Project Physics from persons in the school's decision-making hierarchy. Adoption was favored significantly when teachers perceived the support of any one of: the superintendent ($p=2\times10^{-5}$), the principal ($p=2\times10^{-5}$) or one or more school board members ($p=0.02$). Although guidance counselor

support joined the cluster, it was not independently related to adoption. The chances of adoption also increased regularly and significantly with increasing numbers of supporters (p=0.03).

(2) Factor 5 (p=0.015) was a cluster of six intercorrelated semantic differential items describing the process of "adopting a new physics course" as important, productive, helpful, wise, professional, and interesting (as opposed to unimportant, unproductive, obstructive, foolish, unprofessional, and dull). Two of the items -- "wise" (p=0.032), and "professional" (p=0.047) -- were significantly and monotonically related to an increased likelihood of adoption. Three of the relationships, although they did not quite reach the 0.05 significance level, were distinctly monotonic -- "productive" (p=0.09), "important" (p=0.13), and "helpful" (p=0.14). Although the final item -- "interesting" -- was neither significant nor monotonic, the cluster of six variables collectively discriminated between the adopters and non-adopters more significantly than any one of the component variables.

(3) Factor 7 (p=0.008) was a cluster of four intercorrelated variables descriptive of the teacher. Two of the variables were significantly and monotonically related to an increased likelihood of adopting Project Physics: the teacher was frequently sought out by other teachers for science curricular advice (p=0.024), and the teacher submitted numerous Project Physics summer institute applications

> (p=0.036). The remaining two variables, although not significantly related to adoption, changed monotonically with the likelihood of adoption: the teacher frequently attended professional meetings (p=0.09), and the teacher has recently attended a course for academic credit (p=0.14). Once again, the cumulative effect of the four components yielded a <u>cluster</u> more significantly related to the likelihood of adoption of Project Physics than was any one of its components.

The <u>age of the teacher</u> joined no cluster, but it was both monotonically and significantly related to the likelihood of adoption, although individually significant and monotonic relationships were scattered among them:

(1) Factor 1 (p=0.8) consisted of thirteen intercorrelated semantic differential items describing the <u>process of "adopting a new physics course"</u> as dependable, trustworthy, strong, etc. Only one of this list of adjectives was related significantly to adoption: "professional" (p=0.047). (This variable was one of three that appeared in two clusters.)

(2) Factor 2(p=0.11) consisted of three intercorrelated variables descriptive of the <u>school's history of adopting</u> science courses. Although only one of the variables was related significantly to adoption, the total factor approached significance. The single variable significantly related to adoption was the number of other new science courses adopted by the

school (p=0.002) -- with the likelihood of adoption of Project Physics increasing regularly with increases in the number of new science courses already adopted. The histories of adopting BSCS and CHEMS, the two most commonly used of the "new science courses," were not related simply to the adoption of Project Physics.

(3) Factor 3 (p=0.5) was a cluster of four semantic differential items descriptive of the guidance counselor as professional, supporting, important, and a friend (vs. unprofessional, undermining, unimportant, and an enemy). None of these variables was significantly related to the likelihood of adopting Project Physics.

(4) Factor 6 (p=0.85) was a cluster of four intercorrelated variables dominated by descriptions of the teacher's relationship with his department head. Only one of these variables was significantly and monotonically related to the adoption of Project Physics: the teacher's perception of support to adopt from the science department head (p=0.001). This was the variable most strongly related to adoption in the entire collection of variables (gamma=0.655).

The remaining three variables were not related to the likelihood of adoption: (a) teacher perception of the department head's prior awareness of his (the teacher's) summer institute plans; (b) teacher perception of the curriculum coordinator's prior awareness of his (the teacher's) summer institute plans; (c) the recency of renovation in the school's science facility.

(5) Factor 8 (p=1) was a cluster of three intercorrelated variables. The number of "significant others" the teacher perceived as supporting his adoption proposal (p=0.028) was the only variable in this set significantly and montonically related to the likelihood of adoption. The number of "significant others" the teacher perceived as having prior awareness of his summer institute plans, was related monotonically but not significantly (p=0.11); and the number of new courses adopted by the school in all subjects was not related to the likelihood of adoption of Project Physics.

Generalizability

A random national sample[2] of 484 American physics teachers was polled with a questionnaire nearly identical to that used with physics teachers who had attended Project Physics summer institutes to provide a basis for estimating the generalizability of the findings based upon the sample of Project Physics summer institute attenders. Significant differences (at the 0.05 level) were found in more than 29% of the responses to 238 questionnaire items compared by t-tests. The distribution, directions, and numbers of differences indicated that the (institute-attending) non-adopters resembled the random national sample in most (83%) of the dimensions which had significantly distinguished adopters from non-adopters.

These differences occurred in spite of the moderate bias of the random national sample favoring responses from teachers who were acquainted with Project Physics, and who were professionally similar to institute attenders (see Note 2). Therefore, the traits which characterized adopters in the restricted sample of institute attenders would characterize even more strongly the adopters in a general sample of American physics teachers.

This chapter was intended to briefly describe the companion study and to indicate the parts of this study which have been successfully "replicated." A complete report of the companion study may be found elsewhere.[3]

Chapter V

Footnotes

1 John F. Yegge, "The Adoption of an Innovation in Physics Teaching" (Unpublished doctoral thesis, Harvard University, 1971).

2 The randomness of the respondents in this sample was tested by t-test comparisons of the mean responses of 163 respondents on 239 questionnaire items with those of a telephoned randomly selected subsample of 12 of the non-respondents. The two groups differed at the 0.05 level on 12% of the items: (1) The respondents were more likely to be planning to adopt (or were perhaps more familiar with) Project Physics; (2) The respondents had stronger professional characteristics -- (a) had attended more summer institutes, (b) had stronger educational backgrounds, (c) were more sought after for advice on curricular matters, etc.; but (3) The non-respondents viewed physics, the adoption process, and people in the school's decision-making hierarchy more favorably. Item (3) above seems inconsistent with Items (1) and (2). The seeming inconsistency may have been caused by changes in attitude response sets among the teachers who were singled out to be asked for their responses by long-distance telephone call.

3 Yegge, ibid.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

The data and analyses in this report have led to the following conclusions:

(1) The physics teacher is the most important single person in the process of adopting a new physics course in American high schools.

(2) Five intercorrelated clusters of variables are positively related to American teachers' <u>expectations of adopting</u> Project Physics:

(a) the teachers' perceptions of the social acceptability of the adoption process.

(b) the teachers' perceptions of their schools' histories of, and climates for, change.

(c) the teachers' perceptions of program support from their schools' guidance counselors.

(d) the teachers' perceptions of administrative support for their adoption proposals.

(e) the teachers' perceptions of the value or wisdom of the adoption process.

(3) A companion study replicated the five clusters listed above in an independent set of data and showed that (d) and (e) above are related positively to adoption of Project Physics as well as to teachers' expectations of adoption.

(4) The adoption of Project Physics also is positively related to a cluster of four variables descriptive of professional characteristics of teachers.

(5) Both teachers' expectations of adoption and actual adoption of Project Physics are negatively related to teachers' ages.

(6) A comparison of a sample of teachers attending Project Physics summer institutes and a random national sample of physics teachers suggests that the above conclusions are generalizable to all American physics teachers.

We believe that the risk of generalizing these findings to the adoption of courses other than physics increases with increasing numbers of persons in a school who will teach the course after it is adopted. Accordingly, the adoption for single offering courses that will be offered by one teacher with a unique subject matter expertise will probably closely resemble the physics course adoption process described here. Examples of such courses include advanced chemistry, advanced biology, trigonometry, solid geometry, calculus, etc.

The findings of this study suggest actions by several groups which could, directly or indirectly, help expedite the adoption of new physics (and similar) courses in American schools. The groups include teachers; school administrators; foundations (public and private) which finance the development of new courses or other educational innovations; directors of institutes (summer or other); and educational policy makers such as state and regional supervisors, leaders in professional societies, and editors of professional journals.

The <u>teacher</u> who is aware of the importance of obtaining the support of persons in the decision-making hierarchy could begin by informing "significant others" in the school's decision-making process of his proposed innovation, and by providing them with the kinds of information that they need when they need it. Principals and superintendents need financial information in time to arrange budgetary provisions. Guidance counselors need to know, shortly before implementation: the goals of a proposed new course, changes in academic prerequisites, the types of students toward whom it is directed, and what changes in student behaviors to expect. Other teachers need to know at the time of implementation, how the new course will relate to their own courses and what changes in their own teaching behavior, if any, would contribute to achieving the school's total educational objectives.

<u>Summer institute directors</u> could provide important assistance to the segment of American physics teachers who find it difficult to singlehandedly enlist the administrative support they need for adoption because of teacher-administrator interpersonal problems. This could be done by institute directors sending, in the Spring preceding summer institutes, letters to "significant others" (1) informing them of the summer institute plans of the teacher, (2) generally describing the nature of the institute and the course, and (3) suggesting that the members of the rest of the decision-making hierarchy meet with the teacher to discuss the course in the light of the objectives of the school. This action might well initiate activities that the teacher would personally find difficult to initiate himself.[1]

The physics teacher is, however, the single most important agent for change in new physics course adoptions, and institute directors should support this role. Accordingly, the institute director should keep the teacher fully informed (say, by sending him carbon copies of all related correspondence), and should cast him from the beginning in the role of curriculum innovator. The summer institute director will have thus become a change agent (defined by Carlson as a "person who attempts to influence the adoption decisions in a direction he feels is desirable"[2]). According to Carlson, the absence of real change agents in schools accounts for the present slow rate of change in schools.[3]

Activities at summer institutes could also provide teachers with considerable help. For example, a few "cases" might be written by teachers who have gone through the decision-making process (both successfully and otherwise) that describe, with no interpretation, the people involved and the events leading to, going through, and following the process. Small group discussions of these cases could help teachers place their own roles in clearer perspective. Nearly forty such cases, compiled by Johnson[4] for business school students, could serve as models for preparing cases for teachers.

Since the age of the teacher is inversely and independently related to the adoption of Project Physics, the directors of summer and inservice institutes may wish to give preference to youthful teachers. The probable error, however, in predicting expectation of adoption based on the knowledge of the teacher's age alone is reduced only 20% (gamma=0.020).[5]

An improved application form for institute directors desiring to increase adoption levels of a new physics course would request, in addition to the teacher's age, information related to: (1) the amount of administrative support the teacher has, (2) the way the teacher perceives the adoption process, (3) the amount of professional activity of the teacher, (4) the history of the school in adopting other new science courses, and (5) a count of the number of summer institute applications submitted by the teacher that year. Although institute directors have the option of asking applicants for further information (within the limits of the laws on discrimination) to help in participant selection, the efficiency of the participant-selection process would be improved nationwide if the _funders_ modified their application forms and provided institute directors with guidelines to help them select participants most appropriate to particular program objectives.

Funds committed to course development, and teacher training in the use of new teaching materials and methods, in no way insure that the benefits of the investment will reach many classrooms. The federal agencies, such as the NSF and OE, that administer funds for the support of in-service teacher education, could provide important support to the diffusion of innovations by urging directors of summer and in-service institutes to help teachers work effectively in adoption decision-making. Here, also, we believe that the case study method would be an effective method to provide teachers with such help.

If the efforts of teacher educators are limited to summer institutes, however, the ultimate effect on science education will be slight. We noted earlier (p.) that while 3% of the Nation's pool of physics teachers attended a Project Physics summer institute in 1970 (perhaps 8% attended any physics teacher institute), the teacher "turnover rate" is about 8% per year. In order to substantially increase the effectiveness of the physics course adoption decision-making process, efforts must also be focussed on _undergraduate teacher education_. Pre-service teacher education often ignores many of the political and interpersonal dimensions in which decisions (it has been shown in this paper) regarding educational innovations are made.[6] A pre-service teacher education program which includes study of the typical school decision-making mechanisms, and "case studies" illustrating various kinds of curricular decisions being made, would produce teachers better able to understand and cope with their roles as agents for change in education.

The above suggestions would probably also affect teacher perception of the adoption process (Factor 5, which related innovativeness -- as measured by expectation of Project Physics course adoption -- to teacher perception of the adoption process as important, productive, wise, professional, and helpful). Current pre-service and in-service teacher education, by neglecting the adoption process, implies that the process of adoption is not particularly important, productive, wise, professional, or helpful. School administrators and teacher educators could increase teacher sensitivity to the importance, productivity, etc. of the adoption process by themselves acknowledging the importance of these attitudes, and by stressing their importance to teachers.

Physics teachers who are professionally active tend to be more innovative (defined in terms of expectation of Project Physics course adoption). Innovativeness, willingness to accept change, etc., however, may be <u>part of</u> the "professionality" of teachers rather than simply being <u>related</u> to it. There is indirect evidence to support this supposition: the independent variable that perhaps best estimates physics teacher innovativeness is the frequency with which he is sought out by other teachers for advice on new physics courses; and, in the companion study, the advice variable loaded most heavily on the "teacher professionality" factor (Factor 7). Thus if adoption, the dependent variable, had been included in the factor analysis with the independent variables, adoption might reasonably have been expected to join the "teacher professionality" factor.

Innovativeness in teachers <u>might</u> be increased by subsidizing professional activities of teachers (attendance at professional meetings, subscriptions to professional journals, and tuition for additional course work), but this suggestion assumes a causal relationship between, rather than an identity of, teacher professionality and innovativeness. The effectiveness of a "professionalization" program might, however, be heightened if the meetings, journals, and courses provided help for teachers to better understand, and work more effectively in, the decision-making process.

Policy makers at the state, regional, and national levels (including editors of professional journals and leaders of professional societies), could have considerable influence in stimulating the appraisal and potential adoption of new courses. By virtue of their offices and prestige, these persons are able to focus the attention of many educators on the importance of the adoption decision-making process through such media as journal articles, editorials, and addresses at professional meetings.

<u>Private and public foundations</u>, which support the development of educational innovations, could increase the diffusion of innovations in schools by taking an active and timely interest in curriculum implementation.. Four forms which this interest could take are: (1) fund teams of teachers and teacher educators to prepare and disseminate examples ("cases") illustrating the adoption process under various conditions, and thereby improve the understanding of both pre-service and in-service teachers of the course adoption decision-making process; (2) modify teacher institute application forms (and provide guidelines for their interpretation) to provide institute directors

with information for selection of participants maximally likely to match their institute objectives; (3) fund research to determine the most effective implementation mechanisms for the various other types of curriculum innovations being developed; and (4) encourage and fund, as part of the course development process, early and continuous dissemination of information through journals, meetings, and newsletters to schoolmen about new courses.

The following brief and roughly sequential outline suggests the kinds of activities which foundations supporting the development of physics curriculum materials might well urge and finance to insure the maximum use of innovations after they are completed:

(1) A continuous flow of information from curriculum developers to teachers and science supervisors via journal articles and presentations at professional meetings;

(2) Articles, near the date of publication, in the specific journals for groups in the decision-making hierarchy (such as superintendents, principals, guidance counselors and school board members);

(3) Exhibits at regional and national meetings for teachers and supervisors;

(4) Direct contact with the teacher educators responsible for informing preservice teachers of curriculum developments. (This group of educators is diffuse and difficult to contact although organizations such as the Association for Supervision and Curriculum Development, and the Association for the Education of Teachers in Science might effectively influence teacher educators through their publi-

cations and regional and national meetings.)

(5) <u>Planning sessions</u> in which potential summer institute directors meet with curriculum developers to creat institute strategies of maximum effectiveness and suitability <u>before</u> proposals are written and support staffs are acquired.

In conclusion, curriculum innovation is the concern of, and is sensitive to the influence of, persons in virtually every education stratum from teachers and school administrators at the implementation level to foundations, curriculum developers, and others at the policy-making level. The maximum educational benefit will be achieved by the informed efforts of each level coordinated with those of the entire network of concerned educators.

Chapter VI

Footnotes

1 There is a mild procedural problem in this suggestion because some teachers might consider such letters to be a "violation of confidence." More than 10% of the sample of teachers examined in the companion study had not informed their department chairmen of their summer institute plans. Five percent of the teachers told no one in the decision-making hierarchy. (The adoption rate of Project Physics among this 5% was only 60% that of the entire sample.) Since some teachers might not wish their summer plans to become known in their schools, summer institute directors could avoid the difficulty by including, among teacher application materials, a request for the name of the local community newspaper to which a news release would be sent. Teachers who provide this information tacitly consent to having their summer plans made public and thus would not be undermined by school administrators' receiving mail regarding their summer plans. Proper protocol, of course, dictates that communication be established with administrators before news releases are actually sent.

2 Richard O. Carlson, "Barriers to Change in Public Schools," in Change Processes in Public Schools, ed. by Richard O. Carlson and Keith Goldhammer (Eugene, Oregon: The Center for the Advanced Study of Educational Administration,1965),p.4.

3 Ibid.

4 Rossall J. Johnson, Executive Decisions: Human Element Factors, Management Functions, Social Responsibility (Cincinnati: South-Western Publishing Company, 1963).

5 It is well known that institute directors find participant selection to be a difficult and uncertain task with variations in selection criteria resulting in little noticeable difference in groups selected. Striking evidence of this was found in the companion study in the absence of an "institute effect" linking the institute attended with the likelihood of adopting Project Physics. Some Project Physics summer institute directors have a policy of requiring applicants to furnish evidence that the new course will be adopted. As a result, this study showed a strong relationship between institute attended and expectation of adoption, ($p=10^{-5}$). In terms of actual adoption as shown in the companion study, however, the relationship faded to non-significance ($p=0.11$).

6 David E. Newton and Fletcher G. Watson, The Research on Science Education Survey (Cambridge: Harvard Graduate School of Education, 1968), p.84.

APPENDIX A

IMPLEMENTATION CONFERENCE QUESTIONNAIRE

ADMINISTERED TO TEACHERS

SCIENCE COURSE IMPLEMENTATION QUESTIONNAIRE

Please answer the following questions as accurately as you can.

I

Name ________________________________(1-2)

Adress ________________________________

Title

____1) Curriculum coordinator
____2) Guidance counselor
____3) Principal or assistant principal
____4) Science supervisor (of a school system)
____5) Science department chairman and teacher
____6) Superintendent
____7) Teacher
____8) Other (specify) ________________(3)

Sex

____1) Male
____2) Female (4)

Summer institute ________________________(5-6)

01(7-8)

1. How old are you?
   ____1) 30 or under
   ____2) 31-36
   ____3) 37-42
   ____4) 43-48
   ____5) 49-54
   ____6) 55-60
   ____7) Over 60 (9)

2. During the last 12 months, how many professional meetings have you attended outside of your immediate geographical area (i.e. takes more than one hour to drive)?
   ____1) 1 ____6) 6
   ____2) 2 ____7) 7
   ____3) 3 ____8) 8
   ____4) 4 ____9) 9 or more (10)
   ____5) 5

3. What is your highest academic degree?
   ___1) B.A., B.S., or B.Ed.
   ___2) B.A., B.S. or B.Ed., plus some graduate work
   ___3) M.A., M.S., or Ed.M.
   ___4) M.A., M.S., or Ed.M. plus additional graduate study
   ___5) Ed.D or Ph.D.

4. In what year did you receive your highest academic degree?

___1) Before 1930	___6) '51-'55
___2) '31-'35	___7) '56-'60
___3) '36-'40	___8) '61-'65
___4) '41-'45	___9) '66-'70 (12)
___5) '46-'50	

5. List the professional journals you read routinely (abbreviate if necessary).

   ____
   ____ (13)

6. In what year (prior to 1970) did you take your last course for academic credit?

___1) Before '54	___6) '62-'63
___2) '54-'55	___7) '64-'65
___3) '56-'57	___8) '66-'67
___4) '58-'59	___9) '68-'69 (14)
___5) '60-'61	

7. From approximately how many persons outside of your own school or school system have you actively sought advice or information about new science courses during the last 12 months? ________________ (15)

8. List (by initials) the local professional organizations to which you belong. (Circle those in which you are or have been an officer.)

   ____
   ____ (16)
   (17)

9. List (by initials) the national professional organizations to which you belong. (Circle those in which you are or have been an officer.)

____

____ (18)

(19)

10. Approximately how many journal articles have you published? ____________________ (20)

(Note: In the following questions, the term "school" refers to the school to which the teacher attending this summer institute is assigned.)

11. Which grades are enrolled in the school?

____1) 10th-12th ____3) 7th-12th

____2) 9th-12th ____4) Other specify ______________ (21)

12. What is the approximate total enrollment of the school?

____1) 0-250

____2) 251-500

____3) 501-750

____4) 751-1000

____5) 1001-1250

____6) 1251-1500

____7) 1501-1750

____8) 1751-2000

____9) Over 2000 (22)

13. How is the school best characterized? (check one)

____1) General education

____2) Technical education

____3) College preparatory

____4) Other (specify) ____________________ (23)

14. The school is

____1) Public ____3) Church affiliated

____2) Independent ____4) Other (specify) ____________ (24)

15. The students in the school are

____1) All boarders

____2) Mostly boarders

____3) Partly boarders

____4) No boarders (25)

16. The students are
    ___1) All boys
    ___2) All girls
    ___3) Mixed, boys and girls (26)

17. How many combined junior-senior high schools are there in your school system? ______(27-28)

18. How many high schools are there in your school system? (Do not include the schools listed in question 17.) ____________ (29-30)

19. How many junior high schools are there in your school system? (Do not include the schools listed in question 17.) ____ (31-32)

20. How many combined junior-senior high schools are there in the town your school is in? ____________ (33-34)

21. How many high schools are there in the town your school is in? (Do not include the schools listed in question 20.) _____ (35-36)

22. How many junior high schools are there in the town your school is in? (Do not include the schools listed in question 20.) _____ (37-38)

23. Approximately when was your school building built?

___1) Before 1931	___6) '51-'55
___2) '31-'35	___7) '56-'60
___3) '36-'40	___8) '61-'65
___4) '41-'45	___9) '66-'70
___5) '46-'50	

24. When was the last major remodeling or renovation in the science facility of your school? (Make <u>no reply</u> if "never.")

___1) Before 1931	___6) '51-'55
___2) '31-'35	___7) '56-'60
___3) '36-'40	___8) '61-'65
___4) '41-'45	___9) '66-'70 (40)
___5) '46-'50	

25. How would you classify your school with regard to the area it serves? (check only one.)
 ___1) Urban: Stable population
 ___2) Urban: Transient population
 ___3) Urban: Ghetto
 ___4) Suburban: Upper income level
 ___5) Suburban: Upper and middle income level
 ___6) Suburban: Middle income level
 ___7) Town
 ___8) Rural
 ___9) Other (specify) ______________ (41)

26. What is the title of the person whose estimate of the quality of your work is most important to you? (Check one.)
 ___1) Curriculum coordinator
 ___2) Fellow teacher
 ___3) Guidance counselor
 ___4) Principal or assistant principal
 ___5) Science department chairman
 ___6) Science supervisor
 ___7) School board member(s)
 ___8) Superintendent
 ___9) Other (specify) ________________ (42)

27. What is the title of the person whose estimate of the quality of your work is likely to be most accurate? (Check one.)
 ___1) Curriculum coordinator
 ___2) Fellow teacher
 ___3) Guidance counselor
 ___4) Principal or assistant principal
 ___5) Science department chairman
 ___6) Science supervisor
 ___7) School board member(s)
 ___8) Superintendent
 ___9) Other (specify) ________________ (43)

28. Which of the following events have occurred in your school during the past 12 months? (
(Check all that apply)
 ___a. A threatened teachers' strike
 ___b. A teachers' strike
 ___c. A student boycott of classes

____d. A threatened student boycott of classes
____e. A threatened or actual loss of accreditation
____f. A sudden large increase in enrollment (e.g. because of school consolidation or closing of nearby parochial school.)
____g. Other major disturbing event (specify) ____________ (44)

29. List as many as you can of the new courses (in all subject areas) that have been adopted in your school during the last five years (abbreviate if necessary).

____

____ (45-46)

30. In which year were each of the following new science courses first used in your school? (Make no entry if the course was never used.)

________PSSC physics (47-48)
________CBA chemistry (47-48)
________CHEMStudy chemistry (51-52)
________BSCS biology (53-54)
________IPS (Introductory Physical Science) (55-56)
________ESCP (Earth Sc.Curr.Proj.) (57-58)
________Other (specify) __________ (59-60) (61)

31. How would you rate the competitiveness of your school with other nearby schools in each of the following?

	Very Comptetitive		Moderately Competitive		Weakly Competitive	
	5	4	3	2	1	
Athletics	0	0	0	0	0	(62)
Debating	0	0	0	0	0	(63)
Science fairs or other science contests	0	0	0	0	0	(64)
Quality of curriculum	0	0	0	0	0	(65)
Adoption of new courses	0	0	0	0	0	(66)

32. In what year did you first hear of Project Physics?

____1) 1965 ____4) 1968
____2) 1966 ____5) 1969
____3) 1967 ____6) 1970 (67)

33. Through which medium did you first hear of Project Physics? (Check one.)

____1) Professional publication (such as <u>The Physics Teacher</u>)
____2) Project Physics informational material (such as newsletters)
____3) Commercial promotional material (Damon, Holt, etc.)
____4) Convention or other professional meeting
____5) Mentioned by a colleague
____6) Other (specify) ________________ (68)

34. Was Project Physics taught in your school last year?

____1) Yes ____2) No (69)

If "yes," which was the first year?

____1) 1965-66 ____4) 1968-69
____2) 1966-67 ____5) 1969-70 (70)
____3) 1967-68

If "no," when will use of Project Physics probably begin?

____1) 1970-71 ____4) 1973-74
____2) 1971-72 ____5) It will probably not be adopted
____3) 1972-73 (71)

35. Please estimate the importance of each of the following factors to any delay between the end of the summer training program in Project Physics and the beginning of use of Project Physics in your school

	very important		mod. important		not important	
	5	4	3	2	1	
Waiting for completion of the commercial edition of the printed materials	0	0	0	0	0	(72)
Needed time to get funds	0	0	0	0	0	(73)
Need time to convince the school administration	0	0	0	0	0	(74)
Delay in getting school board approval	0	0	0	0	0	(75)
Need for time to think it over	0	0	0	0	0	(76)
Science dept.head opposition	0	0	0	0	0	(77)
Science supervisor opposition	0	0	0	0	0	(78)
Guidance counselor opposition	0	0	0	0	0	(79)

II
02 (7-8)

Other important factors (specify)

____________	0	0	0	0	0	(9)
____________	0	0	0	0	0	(10)

36. How would you evaluate the importance of each of the following to the adoption of a new course of study in science in your school?

	very important	mod. important		not important		
	5	4	3	2	1	
Curriculum coordinator	0	0	0	0	0	(11)
Guidance counselor	0	0	0	0	0	(12)
Local community	0	0	0	0	0	(13)
P.T.A.	0	0	0	0	0	(14)
Principal or asst. principal	0	0	0	0	0	(15)
Science teacher	0	0	0	0	0	(16)
Science supervisor	0	0	0	0	0	(17)
Students	0	0	0	0	0	(18)
Superintendent	0	0	0	0	0	(19)

37. In your school, which <u>single person</u> is most likely to <u>initiate</u> action with regard to adopting a new <u>physics</u> course? (Check one.)

____1) Curriculum coordinator
____2) Guidance counselor
____3) Physics teacher
____4) Principal or asst.principal
____5) Science supervisor
____6) Science department chairman
____7) Students
____8) Superintendent
____9) Other (specify) ________________ (20)

38. Which of the following would probably be involved in making the final decision regarding the adoption of Project Physics in your school? (Check all that apply.)

____1) Curriculum coordinator (21)
____2) Guidance counselor (22)
____3) Physics teacher (23)
____4) Principal or asst.principal (24)
____5) Science supervisor (25)
____6) Science department chairman (26)
____7) Students (27)
____8) Superintendent (28)
____9) Other (specify) ____________ (29) (30)

39. Please indicate the sequence of events which you think would probably occur if Project Physics were adopted in your school. Indicate the sequence by numbers (1,2,3,...) leaving those blank which you do not believe would occur.

____01) Superintendent gets interested (31-32)
____02) Science supervisor approves (33-34)
____03) Science department head gets interested (35-36)
____04) Parents get interested (37-38)
____05) Guidance counselor approves (39-40)
____06) Guidance counselor gets interested (41-42)
____07) Superintendent approves (43-44)
____08) Science supervisor gets interested (45-46)
____09) Science staff approves (47-48)
____10) School board approves (49-50)
____11) Physics teacher gets interested (51-52)
____12) Principal gets intetested (53-54)
____13) Principal approves (55-56)
____14) Curriculum director gets interested (57-58)
____15) Curriculum director approves (59-60)
(61)

40. Do you believe that the pattern of adoption for physics courses is similar to that in the following:

	Yes (1)	No (2)	
The other sciences	0	0	(62)
Mathematics	0	0	(63)
Social studies	0	0	(64)
English	0	0	(65)
Languages	0	0	(66)

41. Do you believe that the difficulties of adoption for physics are similar to those in the following:

	Yes (1)	No (2)	
The other sciences	0	0	(67)
Mathematics	0	0	(68)
Social Studies	0	0	(69)
English	0	0	(70)
Languages	0	0	(71)

42. How would you evaluate the importance of each of the following factors with regard to providing incentive to adopt new courses of study in science in your school?

	very important		mod important	not important		
	5	4	3	2	1	
Parents encourage introduction of new courses	0	0	0	0	0	(72)
School board encourages introduction of new courses	0	0	0	0	0	(73)
New courses are being adopted in other schools	0	0	0	0	0	(74)
Students want new courses	0	0	0	0	0	(75)
A school accreditation body encourages it	0	0	0	0	0	(76)

43. How would you classify each of the following with regard to its receptivity to being changed?

	very receptive 5	4	mod. receptive 3	2	not receptive 1	
Business and industry	0	0	0	0	0	(77)
Churches	0	0	0	0	0	(78)
Clergy	0	0	0	0	0	(79)
Federal government	0	0	0	0	0	(80)
						III 03 (7-8)
Guidance counselors	0	0	0	0	0	(9)
Local government	0	0	0	0	0	(10)
Politicians	0	0	0	0	0	(11)
Schools	0	0	0	0	0	(12)
School boards	0	0	0	0	0	(13)
School administrators	0	0	0	0	0	(14)
Science teachers	0	0	0	0	0	(15)
Students	0	0	0	0	0	(16)

44. How would you classify each of the following with regard to their actual ability to bring about changes in your community?

	Very Able 5	4	Mod. Able 3	2	Not Able 1	
Bussines and industry	0	0	0	0	0	(17)
Churches	0	0	0	0	0	(18)
Clergy	0	0	0	0	0	(19)
Federal government	0	0	0	0	0	(20)
Guidance counselors	0	0	0	0	0	(21)
Local government	0	0	0	0	0	(22)
Politicians	0	0	0	0	0	(23)
Schools	0	0	0	0	0	(24)
School boards	0	0	0	0	0	(25)
School administrators	0	0	0	0	0	(26)
Science teachers	0	0	0	0	0	(27)
Students	0	0	0	0	0	(28)

45. Will you teach in the same school next year as last year?
___1) Yes ___2) No (29)

46. Who provided the <u>initial</u> impetus for you to apply for a Project Physics summer institute? (Check one.)
___1) Fellow teacher
___2) Guidance counselor
___3) NSF publicity
___4) Principal or asst. principal
___5) Science department chairman
___6) Science supervisor
___7) Superintendent
___8) Yourself
___9) Other (specify) ________________ (30)

47. For how many years have you held your present position?

___1) 0	___6) 9-10
___2) 1-2	___7) 11-12
___3) 3-4	___8) 13-14
___4) 5-6	___9) 15 or more (31)
___5) 7-8	

48. What fraction of your teaching time is devoted to teaching physics?
___1) one-third or less
___2) one-third to two-thirds
___3) more than two-thirds (32)

49. Check <u>each</u> of the following persons that you believe enthusiastically support your adopting Project Physics.
___a. Superintendent (33)
___b. Science department head (34)
___c. Guidance counselor (35)
___d. A consultant from outside the school or school system (36)
___e. Curriculum coordinator (37)
___f. Science supervisor (38)
___g. Principal or asst.principal (39)
___h. A member of the school board (40)(41)

50. What fraction of your Project Physics summer institute would you estimate is devoted to the philosophy and methodology of Project Physics?

___01) 0-10%	___06) 51-60%
___02) 11-20%	___07) 61-70%
___03) 21-30%	___08) 71-80%
___04) 31-40%	___09) 81-90%
___05) 41-50%	___10) 91-100% (42)

51. To how many Project Physics summer institutes did you apply in each of the following years? (Write in number.)

___1) 1968 (43)
___2) 1969 (44)
___3) 1970 (45)

52. Which of the following knew the general nature of Project Physics before you left for this summer's institute? (Check all that apply.)

___a. Curriculum coordinator (46)
___b. Guidance counselor (47)
___c. Principal or asst. principal (48)
___d. Science department head (49)
___e. Science supervisor (50)
___f. Superintendent (51)
___g. Yourself (52)
(53)

53. Before this summer's institute began, had the decision already been made to adopt Project Physics?

___1) Yes ___2) No (54)

54. Of the following, which were aware of your summer institute plans in June,1970? (Check all that apply)

___a. Curriculum coordinator (55)
___b. Guidance counselor (56)
___c. Principal or asst. principal (57)
___d. Science department head (58)
___e. School board member(s) (59)
___f. Science supervisor (60)
___g. Superintendent (61)
(62)

55. If you were to adopt Project Physics, how difficult do you believe your first year would be compared with the previous course in physics that you taught?
___1) More difficult
___2) About the same
___3) Easier (63)

56. In the long run, how difficult do you believe Project Physics would be for you to teach compared with the physics course you previously taught?
___1) More difficult
___2) About the same
___3) Easier (64)

57. Do you plan to use selected parts of Project Physics to supplement your usual physics course until the time comes when you can make a general adoption?
___1) Yes ___2) No (65)

58. Which of the following do you consider to be a personal friend (i.e. first name basis)? (Check all that apply.)
___a. Curriculum coordinator (66)
___b. Guidance counselor (67)
___c. Principal or assistant principal (68)
___d. School board member (69)
___e. Science supervisor (70)
___f. Science department head (71)
___g. Superintendent (72)

59. What was your primary undergraduate major? (Check one.)
___1) Biology ___6) Physics
___2) Chemistry ___7) Science education
___3) English ___8) Social studies
___4) Education ___9) Other (specify)
___5) Mathematics __________ (74)

60. If you had a free choice to teach only one subject, which one would it be? (Check one.)

___1) Biology	___6) Mathematics
___2) Chemistry	___7) Physics
___3) Earth science	___8) Social studies
___4) English	___9) Other (specify)
___5) General science	____________ (75)

61. In which region of the country do you teach?

___1) New England	___5) Southwest
___2) Middle Atlantic	___6) West
___3) Southeast	___7) Northwest
___4) South	___8) Midwest (76)

62. How much interaction do you believe you have with other teachers'
___1) Much more than average
___2) More than average
___3) Above average
___4) Less than average
___5) Much less than average (77)

63. How many times in the past 12 months has someone asked your advice on adoption of a science course?
________________ (78)

64. How many times in the past 12 months have you asked someone for advice on adoption of a science course? ________________ (79)

APPENDIX B

INPLEMENTATION CONFERENCE QUESTIONNAIRE

ADMINISTERED TO ADMINISTRATORS

SCIENCE COURSE IMPLEMENTATION QUESTIONNAIRE

Please answer the following questions as accurately as you can.

I

Name ________________________________(1-2)

Adress ________________________________

Title
____1) Curriculum coordinator
____2) Guidance counselor
____3) Principal or assistant principal
____4) Science supervisor (of a school system)
____5) Science department chairman and teacher
____6) Superintendent
____7) Teacher
____8) Other (specify) _______________(3)

Sex
____1) Male
____2) Female (4)

Summer institute ________________________(5-6)
01(7-8)

1. How old are you?
   ____1) 30 or under
   ____2) 31-36
   ____3) 37-42
   ____4) 43-48
   ____5) 49-54
   ____6) 55-60
   ____7) Over 60 (9)

2. During the last 12 months, how many professional meetings have you attended outside of your immediate geographical area (i.e. takes more than one hour to drive)?
   ____1) 1
   ____2) 2
   ____3) 3
   ____4) 4
   ____5) 5
   ____6) 6
   ____7) 7
   ____8) 8
   ____9) 9 or more (10)

3. What is your highest academic degree?
____1) B.A., B.S., or B.Ed.
____2) B.A., B.S. or B.Ed., plus some graduate work
____3) M.A., M.S., or Ed.M.
____4) M.A., M.S., or Ed.M. plus additional graduate study
____5) Ed.D or Ph.D.

4. In what year did you receive your highest academic degree?
____1) Before 1930 ____6) '51-'55
____2) '31-'35 ____7) '56-'60
____3) '36-'40 ____8) '61-'65
____4) '41-'45 ____9) '66-'70 (12)
____5) '46-'50

5. List the professional journals you read routinely (abbreviate if necessary).

____

____ (13)

6. In what year (prior to 1970) did you take your last course for academic credit?
____1) Before '54 ____6) '62-'63
____2) '54-'55 ____7) '64-'65
____3) '56-'57 ____8) '66-'67
____4) '58-'59 ____9) '68-'69 (14)
____5) '60-'61

7. From approximately how many persons outside of your own school or school system have you actively sought advice or information about new science courses during the last 12 months? ________________ (15)

8. List (by initials) the local professional organizations to which you belong. (Circle those in which you are or have been an officer.)

____

____ (16)
(17)

9. List (by initials) the national professional organizations to which you belong. (Circle those in which you are or have been an officer.)

_______________________________________ (18)
_______________________________________ (19)

10. Approximately how many journal articles have you published? ______________ (20)
(Note: In the following questions, the term "school" refers to the school to which the teacher attending this summer institute is assigned.)

11. Which grades are enrolled in the school?
___1) 10th-12th ___3) 7th-12th
___2) 9th-12th ___4) Other specify
____________ (21)

12. What is the approximate total enrollment of the school?
___1) 0-250 ___6) 1251-1500
___2) 251-500 ___7) 1501-1750
___3) 501-750 ___8) 1751-2000
___4) 751-1000 ___9) Over 2000 (22)
___5) 1001-1250

13. How is the school best characterized? (check one)
___1) General education
___2) Technical education
___3) College preparatory
___4) Other (specify) ________________ (23)

14. The school is
___1) Public ___3) Church affiliated
___2) Independent ___4) Other (specify)
__________ (24)

15. The students in the school are
___1) All boarders
___2) Mostly boarders
___3) Partly boarders
___4) No boarders (25)

16. The students are
    ___1) All boys
    ___2) All girls
    ___3) Mixed, boys and girls (26)

17. How many combined junior-senior high schools are there in your school system? ______(27-28)

18. How many high schools are there in your school system? (Do not include the schools listed in question 17.) ____________ (29-30)

19. How many junior high schools are there in your school system? (Do not include the schools listed in question 17.) ____ (31-32)

20. How many combined junior-senior high schools are there in the town your school is in? ____________ (33-34)

21. How many high schools are there in the town your school is in? (Do not include the schools listed in question 20.) _____ (35-36)

22. How many junior high schools are there in the town your school is in? (Do not include the schools listed in question 20.) _____ (37-38)

23. Approximately when was your school building built?

___1) Before 1931	___6) '51-'55
___2) '31-'35	___7) '56-'60
___3) '36-'40	___8) '61-'65
___4) '41-'45	___9) '66-'70
___5) '46-'50	

24. When was the last major remodeling or renovation in the science facility of your school? (Make <u>no reply</u> if "never.")

___1) Before 1931	___6) '51-'55
___2) '31-'35	___7) '56-'60
___3) '36-'40	___8) '61-'65
___4) '41-'45	___9) '66-'70 (40)
___5) '46-'50	

25. How would you classify your school with regard to the area it serves? (check only one.)
____1) Urban: Stable population
____2) Urban: Transient population
____3) Urban: Ghetto
____4) Suburban: Upper income level
____5) Suburban: Upper and middle income level
____6) Suburban: Middle income level
____7) Town
____8) Rural
____9) Other (specify) ______________ (41)

26. What is the title of the person whose estimate of the quality of your work is <u>most important</u> to you? (Check one.)
____1) Curriculum coordinator
____2) Fellow teacher
____3) Guidance counselor
____4) Principal or assistant principal
____5) Science department chairman
____6) Science supervisor
____7) School board member(s)
____8) Superintendent
____9) Other (specify) ________________ (42)

27. What is the title of the person whose estimate of the quality of your work is likely to be <u>most accurate</u>? (Check one.)
____1) Curriculum coordinator
____2) Fellow teacher
____3) Guidance counselor
____4) Principal or assistant principal
____5) Science department chairman
____6) Science supervisor
____7) School board member(s)
____8) Superintendent
____9) Other (specify) ________________ (43)

28. Which of the following events have occurred in your school during the past 12 months? ((Check all that apply)
____a. A threatened teachers' strike
____b. A teachers' strike
____c. A student boycott of classes

___d. A threatened student boycott of classes
___e. A threatened or actual loss of accreditation
___f. A sudden large increase in enrollment (e.g. because of school consolidation or closing of nearby parochial school.)
___g. Other major disturbing event (specify) ________ (44)

29. List as many as you can of the new courses (in all subject areas) that have been adopted in your school during the last five years (abbreviate if necessary).

____

____________________ (45-46)

30. In which year were each of the following new science courses first used in your school? (Make no entry if the course was never used.)
________PSSC physics (47-48)
________CBA chemistry (47-48)
________CHEMStudy chemistry (51-52)
________BSCS biology (53-54)
________IPS (Introductory Physical Science)(55-56)
________ESCP (Earth Sc.Curr.Proj.) (57-58)
________Other (specify) ________ (59-60) (61)

31. How would you rate the competitiveness of your school with other nearby schools in each of the following?

	Very Comptetitive 5	4	Moderately Competitive 3	2	Weakly Competitive 1	
Athletics	0	0	0	0	0	(62)
Debating	0	0	0	0	0	(63)
Science fairs or other science contests	0	0	0	0	0	(64)
Quality of curriculum	0	0	0	0	0	(65)
Adoption of new courses	0	0	0	0	0	(66)

32. In what year did you first hear of Project Physics?

___1) 1965 ___4) 1968
___2) 1966 ___5) 1969
___3) 1967 ___6) 1970 (67)

33. Through which medium did you first hear of Project Physics? (Check one.)

___1) Professional publication (such as The Physics Teacher)
___2) Project Physics informational material (such as newsletters)
___3) Commercial promotional material (Damon, Holt, etc.)
___4) Convention or other professional meeting
___5) Mentioned by a colleague
___6) Other (specify) _______________ (68)

34. Was Project Physics taught in your school last year?

___1) Yes ___2) No (69)

If "yes," which was the first year?

___1) 1965-66 ___4) 1968-69
___2) 1966-67 ___5) 1969-70 (70)
___3) 1967-68

If "no," when will use of Project Physics probably begin?

___1) 1970-71 ___4) 1973-74
___2) 1971-72 ___5) It will probably not be adopted
___3) 1972-73 (71)

35. Please estimate the importance of each of the following factors to any delay between the end of the summer training program in Project Physics and the beginning of use of Project Physics in your school

	very important 5	4	mod. important 3	2	not important 1	
Waiting for completion of the commercial edition of the printed materials	0	0	0	0	0	(72)
Needed time to get funds	0	0	0	0	0	(73)
Need time to convince the school administration	0	0	0	0	0	(74)
Delay in getting school board approval	0	0	0	0	0	(75)
Need for time to think it over	0	0	0	0	0	(76)
Science dept.head opposition	0	0	0	0	0	(77)
Science supervisor opposition	0	0	0	0	0	(78)
Guidance counselor opposition	0	0	0	0	0	(79)

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02(7-8)

Other important factors (specify)

____________	0	0	0	0	0	(9)
____________	0	0	0	0	0	(10)

36. How would you evaluate the importance of each of the following to the adoption of a new course of study in science in your school?

	very important 5	4	mod. important 3	2	not important 1	
Curriculum coordinator	0	0	0	0	0	(11)
Guidance counselor	0	0	0	0	0	(12)
Local community	0	0	0	0	0	(13)
P.T.A.	0	0	0	0	0	(14)
Principal or asst. principal	0	0	0	0	0	(15)
Science teacher	0	0	0	0	0	(16)
Science supervisor	0	0	0	0	0	(17)
Students	0	0	0	0	0	(18)
Superintendent	0	0	0	0	0	(19)

37. In your school, which single person is most likely to initiate action with regard to adopting a new physics course? (Check one.)

____1) Curriculum coordinator
____2) Guidance counselor
____3) Physics teacher
____4) Principal or asst.principal
____5) Science supervisor
____6) Science department chairman
____7) Students
____8) Superintendent
____9) Other (specify) ________________ (20)

38. Which of the following would probably be involved in making the final decision regarding the adoption of Project Physics in your school? (Check all that apply.)

____1)	Curriculum coordinator	(21)
____2)	Guidance counselor	(22)
____3)	Physics teacher	(23)
____4)	Principal or asst.principal	(24)
____5)	Science supervisor	(25)
____6)	Science department chairman	(26)
____7)	Students	(27)
____8)	Superintendent	(28)
____9)	Other (specify) ____________ (29)	(30)

39. Please indicate the sequence of events which you think would probably occur if Project Physics were adopted in your school. Indicate the sequence by numbers (1,2,3,...) leaving those blank which you do not believe would occur.

____01)	Superintendent gets interested	(31-32)
____02)	Science supervisor approves	(33-34)
____03)	Science department head gets interested	(35-36)
____04)	Parents get interested	(37-38)
____05)	Guidance counselor approves	(39-40)
____06)	Guidance counselor gets interested	(41-42)
____07)	Superintendent approves	(43-44)
____08)	Science supervisor gets interested	(45-46)
____09)	Science staff approves	(47-48)
____10)	School board approves	(49-50)
____11)	Physics teacher gets interested	(51-52)
____12)	Principal gets intetested	(53-54)
____13)	Principal approves	(55-56)
____14)	Curriculum director gets interested	(57-58)
____15)	Curriculum director approves	(59-60)
		(61)

40. Do you believe that the <u>pattern</u> of adoption for physics courses is similar to that in the following:

	Yes (1)	No (2)	
The other sciences	0	0	(62)
Mathematics	0	0	(63)
Social studies	0	0	(64)
English	0	0	(65)
Languages	0	0	(66)

41. Do you believe that the <u>difficulties</u> of adoption for physics are similar to those in the following:

	Yes (1)	No (2)	
The other sciences	0	0	(67)
Mathematics	0	0	(68)
Social Studies	0	0	(69)
English	0	0	(70)
Languages	0	0	(71)

42. How would you evaluate the importance of each of the following factors with regard to <u>providing incentive</u> to adopt new courses of study in science in your school?

	very important		mod important	not important		
	5	4	3	2	1	
Parents encourage introduction of new courses	0	0	0	0	0	(72)
School board encourages introduction of new courses	0	0	0	0	0	(73)
New courses are being adopted in other schools	0	0	0	0	0	(74)
Students want new courses	0	0	0	0	0	(75)
A school accreditation body encourages it	0	0	0	0	0	(76)

43. How would you classify each of the following with regard to its receptivity to being changed?

	very receptive 5	4	mod. receptive 3	2	not receptive 1	
Business and industry	0	0	0	0	0	(77)
Churches	0	0	0	0	0	(78)
Clergy	0	0	0	0	0	(79)
Federal government	0	0	0	0	0	(80)
						III 03 (7-8)
Guidance counselors	0	0	0	0	0	(9)
Local government	0	0	0	0	0	(10)
Politicians	0	0	0	0	0	(11)
Schools	0	0	0	0	0	(12)
School boards	0	0	0	0	0	(13)
School administrators	0	0	0	0	0	(14)
Science teachers	0	0	0	0	0	(15)
Students	0	0	0	0	0	(16)

44. How would you classify each of the following with regard to their actual ability to bring about changes in your community?

	Very Able 5	4	Mod. Able 3	2	Not Able 1	
Bussines and industry	0	0	0	0	0	(17)
Churches	0	0	0	0	0	(18)
Clergy	0	0	0	0	0	(19)
Federal government	0	0	0	0	0	(20)
Guidance counselors	0	0	0	0	0	(21)
Local government	0	0	0	0	0	(22)
Politicians	0	0	0	0	0	(23)
Schools	0	0	0	0	0	(24)
School boards	0	0	0	0	0	(25)
School administrators	0	0	0	0	0	(26)
Science teachers	0	0	0	0	0	(27)
Students	0	0	0	0	0	(28)

On the remainder of this questionnaire, the term "school" refers to the school to which your teacher-colleague who is attending this summer institute is assigned.

45. Who do you believe provided the <u>initial impetus</u> for the teacher with whom you are associated to attend this institute?
____1) Curriculum coordinator
____2) A fellow teacher
____3) NSF publicity
____4) Principal or assistant principal
____5) Guidance counselor
____6) Science department chairman
____7) Science supervisor
____8) The teacher himself III
____9) Other (specify)________________ (80)

46. What is the <u>school's</u> approximate annual per pupil expenditure (current plus capital expenditure)?
____1) $0-300
____2) 301-400
____3) 401-500
____4) 501-600
____5) 601-700 IV
____6) 701-800 04(7-8)
____7) 801-900
____8) 901-1000
____9) More than 1000) (9)

47. What is your school system's approximate annual per pupil expenditure (current plus capital expenditure)?
____1) $0-300 ____6) 701-800
____2) 301-400 ____7) 801-900
____3) 401-500 ____8) 901-1000
____4) 501-600 ____9) More than 1000 (10)
____5) 601-700

48. What percent of the total school budget is spent on central administration?
____________________ (11-12)

49. Who employed you before you assumed your present position?
____1) Your present employer
____2) Some other employer (13)

50. How many times in the past 12 months has someone asked your advice on adoption of a science course? ________________ (14)

51. How many times in the past 12 months have you asked someone for advice on adoption of a science course? ________________ (15)

52. How long have you held your present position? ____________________ years (16-17)

53. How much interaction do you believe you have with other persons who have approximately the same responsibilities you have?
____1) Much more than average
____2) More than average
____3) About average
____4) Less than average
____5) Much less than average (18)

54. How would you rate the support you receive from your immediate superior(s)?
____1) Excellent ____3) Fair
____2) Good ____4) Poor (19)

55. As a teacher, what was your area of <u>chief</u> academic interest?
____1) English
____2) Good
____3) Language(s)
____4) Manual arts
____5) Mathematics
____6) Physical education
____7) Science
____8) Social studies
____9) Other (specify) ________________ (20)

56. Have you ever taught a science?
___1) Yes
___2) No (21)

If yes, for how long? ___________years (22-23)

57. How would you describe your relationship with the physics teacher from your school or school system that is attending this institute?
___1) Close personal friend
___2) Friendly (first name basis)
___3) Acquainted
___4) Not acquainted before this week (24)

APPENDIX C

INSTRUMENTS ADMINISTERED AT ENDS OF

IMPLEMENTATION CONFERENCES

1) Follow-up questionnaire (4 pages)

2) Semantic Differential (7 pages)

3) Test on Understanding Science (not included)

Name ______________

FOLLOW-UP QUESTIONNAIRE

1. Please estimate the importance of each of the following factors to any delay between the end of the summer training program in Project Physics and the beginning of use of Project Physics in your school.

	very important 5	4	mod. important 3	2	not important 1	VI
Waiting for completion of the commercial edition of the printed materials	0	0	0	0	0	(11)
Needed time to get funds	0	0	0	0	0	(12)
Need time to convince the school administration	0	0	0	0	0	(13)
Delay in getting school board approval	0	0	0	0	0	(14)
Need for time to think it over	0	0	0	0	0	(15)
Science department head opposition	0	0	0	0	0	(16)
Science supervisor opposition	0	0	0	0	0	(17)
Guidance counselor opposition	0	0	0	0	0	(18)
Curriculum coordinator opposition	0	0	0	0	0	(19)
Other important factors (specify) ______________	0	0	0	0	0	(20)
______________	0	0	0	0	0	(21)

2. How would you evaluate the importance of each of the following to the adoption of a new course of study in science in your school?

	very important		mod. important		not important	
	5	4	4	3	1	VI
Curriculum coordinator	0	0	0	0	0	(22)
Guidance counselor	0	0	0	0	0	(23)
Local community	0	0	0	0	0	(24)
P.T.A.	0	0	0	0	0	(25)
Principal or asst. principal	0	0	0	0	0	(26)
Science teacher	0	0	0	0	0	(27)
Science supervisor	0	0	0	0	0	(28)
Students	0	0	0	0	0	(29)
Superintendent	0	0	0	0	0	(30)

3. In your school, which single person is most likely to initiate action with regard to adopting a new physics course? (Check one.)

____1) Curriculum coordinator
____2) Guidance counselor
____3) Physics teacher
____4) Principal or assistant principal
____5) Science supervisor
____6) Science department chairman
____7) Students
____8) Superintendent
____9) Other (specify) ______________________ (31)

4. Which of the following would probably be involved in making the final decision regarding the adoption of Project Physics in your school? (Check all that apply.)

____1) Curriculum coordinator		(32)
____2) Guidance counselor		(33)
____3) Physics teacher		(34)
____4) Principal or assistant principal		(35)
____5) Science supervisor		(36)
____6) Science department chairman		(37)
____7) Students		(38)
____8) Superintendent		(39)
____9) Other(specify) ________________	(40)	(41)

5. Please indicate the sequence of events which you think would probably occur if Project Physics were adopted in your school. Indicate the sequence by numbers (1,2,3,...) leaving those blank which you do not believe would occur.

____01) Superintendent gets interested	(42-43)
____02) Science supervisor approves	(44-45)
____03) Science department head gets interested	(46-47)
____04) Parents get interested	(48-49)
____05) Guidance counselor approves	(50-51)
____06) Guidance counselor gets interested	(52-53)
____07) Superintendent approves	(54-55)
____08) Science supervisor gets interested	(56-57)
____09) Science staff approves	(58-59)
____10) School board approves	(60-61)
____11) Physics teacher gets interested	(62-63)
____12) Principal gets interested	(64-65)
____13) Principal approves	(66-67)
____14) Curriculum director gets interested	(68-69)
____15) Curriculum director approves	(70-71)
	(72)

6. Do you believe that the pattern of adoption for physics courses is similar to that in the following:

	Yes(1)	No(2)	
The other sciences	0	0	(73)
Mathematics	0	0	(74)
Social studies	0	0	(75)
English	0	0	(76)
Languages	0	0	(77)

7. Do you believe that the difficulties of adoption for physics are similar to those in the following:

	Yes(1)	No(2)	
The other sciences	0	0	(78)
Mathematics	0	0	(79)
Social Studies	0	0	(80)
			VII 07(7-8)
English	0	0	(9)
Languages	0	0	(10)

8. How would you evaluate the importance of each of the following factors with regard to providing incentive to adopt new courses of study in science in your school?

	very important		mod. important		not important	
	5	4	3	2	1	
Parents encourage introduction of new courses	0	0	0	0	0	(11)
School board encourages introduction of new courses	0	0	0	0	0	(12)
New courses are being adopted in other schools	0	0	0	0	0	(13)
Students want new courses	0	0	0	0	0	(14)
A school accreditation body encourages it	0	0	0	0	0	(15)

9. How would you classify each of the following with regard to its receptivity to being changed?

	very receptive 5	4	mod. receptive 3	2	not receptive 1	
Business and industry	0	0	0	0	0	(16)
Churches	0	0	0	0	0	(17)
Clergy	0	0	0	0	0	(18)
Federal government	0	0	0	0	0	(19)
Guidance counselors	0	0	0	0	0	(20)
Local government	0	0	0	0	0	(21)
Politicians	0	0	0	0	0	(22)
Schools	0	0	0	0	0	(23)
School boards	0	0	0	0	0	(24)
School administrators	0	0	0	0	0	(25)
Science teachers	0	0	0	0	0	(26)
Students	0	0	0	0	0	(27)

10. How would you classify each of the following with regard to their actual ability to bring about changes in your community?

	Very Able 5	4	Mod. Able 3	2	Not Able 1	
Business and industry	0	0	0	0	0	(28)
Churches	0	0	0	0	0	(29)
Clergy	0	0	0	0	0	(30)
Federal government	0	0	0	0	0	(31)
Guidance counselors	0	0	0	0	0	(32)
Local government	0	0	0	0	0	(33)
Politicians	0	0	0	0	0	(34)
Schools	0	0	0	0	0	(35)
School boards	0	0	0	0	0	(36)
School administrators	0	0	0	0	0	(37)
Science teachers	0	0	0	0	0	(38)
Students	0	0	0	0	0	(39)

Name ______________________________

MEDICAL DOCTOR

	7	6	5	4	3	2	1	
Important	0	0	0	0	0	0	0	Unimportant
Unproductive	0	0	0	0	0	0	0	Productive
Authoritarian	0	0	0	0	0	0	0	Democratic
Enemy	0	0	0	0	0	0	0	Friend
Wise	0	0	0	0	0	0	0	Foolish
Comforting	0	0	0	0	0	0	0	Threatening
	7	6	5	4	3	2	1	
Helpful	0	0	0	0	0	0	0	Obstructive
Cruel	0	0	0	0	0	0	0	Kind
Cooperative	0	0	0	0	0	0	0	Antagonistic
Cluttered	0	0	0	0	0	0	0	Orderly
Predictable	0	0	0	0	0	0	0	Unpredictable
Complex	0	0	0	0	0	0	0	Simple
	7	6	5	4	3	2	1	
Reliable	0	0	0	0	0	0	0	Unreliable
Difficult	0	0	0	0	0	0	0	Easy
Aggressive	0	0	0	0	0	0	0	Passive
Wasteful	0	0	0	0	0	0	0	Saving
Trustworthy	0	0	0	0	0	0	0	Untrustworthy
Unsociable	0	0	0	0	0	0	0	Sociable
	7	6	5	4	3	2	1	
Dominant	0	0	0	0	0	0	0	Submissive
Cheerful	0	0	0	0	0	0	0	Solemn
Dependable	0	0	0	0	0	0	0	Undependable
Dull	0	0	0	0	0	0	0	Interesting
Strong	0	0	0	0	0	0	0	Weak
Unsympathetic	0	0	0	0	0	0	0	Sympathetic
	7	6	5	4	3	2	1	
Supporting	0	0	0	0	0	0	0	Undermining
Professional	0	0	0	0	0	0	0	Unprofessional

SCIENCE

	7	6	5	4	3	2	1	
Important	0	0	0	0	0	0	0	Unimportant
Unproductive	0	0	0	0	0	0	0	Productive
Authoritarian	0	0	0	0	0	0	0	Democratic
Enemy	0	0	0	0	0	0	0	Friend
Wise	0	0	0	0	0	0	0	Foolish
Comforting	0	0	0	0	0	0	0	Threatening
	7	6	5	4	3	2	1	
Helpful	0	0	0	0	0	0	0	Obstructive
Cruel	0	0	0	0	0	0	0	Kind
Cooperative	0	0	0	0	0	0	0	Antagonistic
Cluttered	0	0	0	0	0	0	0	Orderly
Predictable	0	0	0	0	0	0	0	Unpredictable
Complex	0	0	0	0	0	0	0	Simple
	7	6	5	4	3	2	1	
Reliable	0	0	0	0	0	0	0	Unreliable
Difficult	0	0	0	0	0	0	0	Easy
Aggressive	0	0	0	0	0	0	0	Passive
Wasteful	0	0	0	0	0	0	0	Saving
Trustworthy	0	0	0	0	0	0	0	Untrustworthy
Unsociable	0	0	0	0	0	0	0	Sociable
	7	6	5	4	3	2	1	
Dominant	0	0	0	0	0	0	0	Submissive
Cheerful	0	0	0	0	0	0	0	Solemn
Dependable	0	0	0	0	0	0	0	Undependable
Dull	0	0	0	0	0	0	0	Interesting
Strong	0	0	0	0	0	0	0	Weak
Unsympathetic	0	0	0	0	0	0	0	Sympathetic
	7	6	5	4	3	2	1	
Supporting	0	0	0	0	0	0	0	Undermining
Professional	0	0	0	0	0	0	0	Unprofessional

PHYSICS

	7	6	5	4	3	2	1		IV
Important	0	0	0	0	0	0	0	Unimportant	(25)
Unproductive	0	0	0	0	0	0	0	Productive	(26)
Authoritarian	0	0	0	0	0	0	0	Democratic	(27)
Enemy	0	0	0	0	0	0	0	Friend	(28)
Wise	0	0	0	0	0	0	0	Foolish	(29)
Comforting	0	0	0	0	0	0	0	Threatening	(30)
	7	6	5	4	3	2	1		
Helpful	0	0	0	0	0	0	0	Obstructive	(31)
Cruel	0	0	0	0	0	0	0	Kind	(32)
Cooperative	0	0	0	0	0	0	0	Antagonistic	(33)
Cluttered	0	0	0	0	0	0	0	Orderly	(34)
Predictable	0	0	0	0	0	0	0	Unpredictable	(35)
Complex	0	0	0	0	0	0	0	Simple	(36)
	7	6	5	4	3	2	1		
Reliable	0	0	0	0	0	0	0	Unreliable	(37)
Difficult	0	0	0	0	0	0	0	Easy	(38)
Aggressive	0	0	0	0	0	0	0	Passive	(39)
Wasteful	0	0	0	0	0	0	0	Saving	(40)
Trustworthy	0	0	0	0	0	0	0	Untrustworthy	(41)
Unsociable	0	0	0	0	0	0	0	Sociable	(42)
	7	6	5	4	3	2	1		
Dominant	0	0	0	0	0	0	0	Submissive	(43)
Cheerful	0	0	0	0	0	0	0	Solemn	(44)
Dependable	0	0	0	0	0	0	0	Undependable	(45)
Dull	0	0	0	0	0	0	0	Interesting	(46)
Strong	0	0	0	0	0	0	0	Weak	(47)
Unsympathetic	0	0	0	0	0	0	0	Sympathetic	(48)
	7	6	5	4	3	2	1		
Supporting	0	0	0	0	0	0	0	Undermining	(49)
Professional	0	0	0	0	0	0	0	Unprofessional	(50)

SUPERINTENDENT

	7	6	5	4	3	2	1		IV
Important	0	0	0	0	0	0	0	Unimportant	(51)
Unproductive	0	0	0	0	0	0	0	Productive	(52)
Authoritarian	0	0	0	0	0	0	0	Democratic	(53)
Enemy	0	0	0	0	0	0	0	Friend	(54)
Wise	0	0	0	0	0	0	0	Foolish	(55)
Comforting	0	0	0	0	0	0	0	Threatening	(56)
	7	6	5	4	3	2	1		
Helpful	0	0	0	0	0	0	0	Obstructive	(57)
Cruel	0	0	0	0	0	0	0	Kind	(58)
Cooperative	0	0	0	0	0	0	0	Antagonistic	(59)
Cluttered	0	0	0	0	0	0	0	Orderly	(60)
Predictable	0	0	0	0	0	0	0	Unpredictable	(61)
Complex	0	0	0	0	0	0	0	Simple	(62)
	7	6	5	4	3	2	1		
Reliable	0	0	0	0	0	0	0	Unreliable	(63)
Difficult	0	0	0	0	0	0	0	Easy	(64)
Aggressive	0	0	0	0	0	0	0	Passive	(65)
Wasteful	0	0	0	0	0	0	0	Saving	(66)
Trustworthy	0	0	0	0	0	0	0	Untrustworthy	(67)
Unsociable	0	0	0	0	0	0	0	Sociable	(68)
	7	6	5	4	3	2	1		
Dominant	0	0	0	0	0	0	0	Submissive	(69)
Cheerful	0	0	0	0	0	0	0	Solemn	(70)
Dependable	0	0	0	0	0	0	0	Undependable	(71)
Dull	0	0	0	0	0	0	0	Interesting	(72)
Strong	0	0	0	0	0	0	0	Weak	(73)
Unsympathetic	0	0	0	0	0	0	0	Sympathetic	(74)
	7	6	5	4	3	2	1		
Supporting	0	0	0	0	0	0	0	Undermining	(75)
Professional	0	0	0	0	0	0	0	Unprofessional	(76)

GUIDANCE COUNSELOR

	7	6	5	4	3	2	1		IV
Important	0	0	0	0	0	0	0	Unimportant	(77)
Unproductive	0	0	0	0	0	0	0	Productive	(78)
Authoritarian	0	0	0	0	0	0	0	Democratic	(79)
Enemy	0	0	0	0	0	0	0	Friend	(80)
									05(7-8)
Wise	0	0	0	0	0	0	0	Foolish	(9)
Comforting	0	0	0	0	0	0	0	Threatening	(10)
	7	6	5	4	3	2	1		
Helpful	0	0	0	0	0	0	0	Obstructive	(11)
Cruel	0	0	0	0	0	0	0	Kind	(12)
Cooperative	0	0	0	0	0	0	0	Antagnonistic	(13)
Cluttered	0	0	0	0	0	0	0	Orderly	(14)
Predictable	0	0	0	0	0	0	0	Unpredictable	(15)
Complex	0	0	0	0	0	0	0	Simple	(16)
	7	6	5	4	3	2	1		
Reliable	0	0	0	0	0	0	0	Unreliable	(17)
Difficult	0	0	0	0	0	0	0	Easy	(18)
Aggressive	0	0	0	0	0	0	0	Passive	(19)
Wasteful	0	0	0	0	0	0	0	Saving	(20)
Trustworthy	0	0	0	0	0	0	0	Untrustworthy	(21)
Unsociable	0	0	0	0	0	0	0	Sociable	(22)
	7	6	5	4	3	2	1		
Dominant	0	0	0	0	0	0	0	Submissive	(23)
Cheerful	0	0	0	0	0	0	0	Solemn	(24)
Dependable	0	0	0	0	0	0	0	Undependable	(25)
Dull	0	0	0	0	0	0	0	Interesting	(26)
Strong	0	0	0	0	0	0	0	Weak	(27)
Unsympathetic	0	0	0	0	0	0	0	Sympathetic	(28)
	7	6	5	4	3	2	1		
Supporting	0	0	0	0	0	0	0	Undermining	(29)
Professional	0	0	0	0	0	0	0	Unprofessional	(30)

PHYSICS TEACHER

	7	6	5	4	3	2	1		V
Important	0	0	0	0	0	0	0	Unimportant	(31)
Unproductive	0	0	0	0	0	0	0	Productive	(32)
Authoritarian	0	0	0	0	0	0	0	Democratic	(33)
Enemy	0	0	0	0	0	0	0	Friend	(34)
Wise	0	0	0	0	0	0	0	Foolish	(35)
Comforting	0	0	0	0	0	0	0	Threatening	(36)
	7	6	5	4	3	2	1		
Helpful	0	0	0	0	0	0	0	Obstructive	(37)
Cruel	0	0	0	0	0	0	0	Kind	(38)
Cooperative	0	0	0	0	0	0	0	Antagonistic	(39)
Cluttered	0	0	0	0	0	0	0	Orderly	(40)
Predictable	0	0	0	0	0	0	0	Unpredictable	(41)
Complex	0	0	0	0	0	0	0	Simple	(42)
	7	6	5	4	3	2	1		
Reliable	0	0	0	0	0	0	0	Unreliable	(43)
Difficult	0	0	0	0	0	0	0	Easy	(44)
Aggressive	0	0	0	0	0	0	0	Passive	(45)
Wasteful	0	0	0	0	0	0	0	Saving	(46)
Trustworthy	0	0	0	0	0	0	0	Untrustworthy	(47)
Unsociable	0	0	0	0	0	0	0	Sociable	(48)
	7	6	5	4	3	2	1		
Dominant	0	0	0	0	0	0	0	Submissive	(49)
Cheerful	0	0	0	0	0	0	0	Solemn	(50)
Dependable	0	0	0	0	0	0	0	Undependable	(51)
Dull	0	0	0	0	0	0	0	Interesting	(52)
Strong	0	0	0	0	0	0	0	Weak	(53)
Unsympathetic	0	0	0	0	0	0	0	Sympathetic	(54)
	7	6	5	4	3	2	1		
Supporting	0	0	0	0	0	0	0	Undermining	(55)
Professional	0	0	0	0	0	0	0	Unprofessional	(56)

ADOPTING A NEW PHYSICS COURSE

	7	6	5	4	3	2	1		
Important	0	0	0	0	0	0	0	Unimportant	(57)
Unproductive	0	0	0	0	0	0	0	Productive	(58)
Authoritarian	0	0	0	0	0	0	0	Democratic	(59)
Enemy	0	0	0	0	0	0	0	Friend	(60)
Wise	0	0	0	0	0	0	0	Foolish	(61)
Comforting	0	0	0	0	0	0	0	Threatening	(62)

	7	6	5	4	3	2	1		
Helpful	0	0	0	0	0	0	0	Obstructive	(63)
Cruel	0	0	0	0	0	0	0	Kind	(64)
Cooperative	0	0	0	0	0	0	0	Antagonistic	(65)
Cluttered	0	0	0	0	0	0	0	Orderly	(66)
Predictable	0	0	0	0	0	0	0	Unpredictable	(67)
Complex	0	0	0	0	0	0	0	Simple	(68)

	7	6	5	4	3	2	1		
Reliable	0	0	0	0	0	0	0	Unreliable	(69)
Difficult	0	0	0	0	0	0	0	Easy	(70)
Aggressive	0	0	0	0	0	0	0	Passive	(71)
Wasteful	0	0	0	0	0	0	0	Saving	(72)
Trustworthy	0	0	0	0	0	0	0	Untrustworthy	(73)
Unsociable	0	0	0	0	0	0	0	Sociable	(74)

	7	6	5	4	3	2	1		
Dominant	0	0	0	0	0	0	0	Submissive	(75)
Cheerful	0	0	0	0	0	0	0	Solemn	(76)
Dependable	0	0	0	0	0	0	0	Undependable	(77)
Dull	0	0	0	0	0	0	0	Interesting	(78)
Strong	0	0	0	0	0	0	0	Weak	(79)
Unsympathetic	0	0	0	0	0	0	0	Sympathetic	(80)

	7	6	5	4	3	2	1	VI	06(7-8)
Supporting	0	0	0	0	0	0	0	Undermining	(9)
Progessional	0	0	0	0	0	0	0	Unprofessional	(10)

IMPLEMENTATION CONFERENCE SMALL GROUP DISCUSSION QUESTIONS

IMPLEMENTATION CONFERENCE GROUP DISCUSSION

QUESTIONS

1. Under what conditions and by what patterns of decision-making are new courses (especially government-sponsored science courses such as Project Physics) adopted by schools?
   A. What are the actual roles of
      teachers
      administrators
      science supervisors
      curriculum coordinators
      guidance personnel
      school boards
      parents
      students
      etc.
   and how do they interrelate with one another?
   B. How do the roles vary in schools and school systems of different sizes?
   C. Is there a typical sequence of events in the decision-making process?

2. Does the adoption process differ by
   Region of the country; School or town size; Type of school; Etc.
   Is the source of the funds with which a course was developed (e.g. federal funds vs. a commercial publishing company) an important consideration in the adoption decision?

IMPLEMENTATION CONFERENCE GROUP DISCUSSION

QUESTIONS

3. What is the normal delay-time between the decision-makers' first knowledge of a new course of study, the decision to use it eventually, and the actual use of the course in the classroom? How important are factors such as
   Shortages of funds to purchase laboratory equipment and books;
   Unavailability of space;
   Obtaining materials once funds become available;
   Preparing teachers to use the new course of study correctly;
   Convincing teacher and parent groups that the change will be beneficial;
   Etc.

4. How does knowledge of new courses get to the various persons involved in the decision-making process and where does the impetus to consider making changes normally start? Does the source of the initial impetus vary with the type of change that is being sought? How important are the influences of other schools adopting new courses of study, national publicity on curriculum developments, professional meetings and journals, the aczdemic community, current world events, etc.? What kind of information about new courses is important to administrators, teachers, guidance counselors, parents, etc.? How is this information "best" gotten to them?

TYPICAL IMPLEMENTATION CONFERENCE SCHEDULE

NSF - Kansas State University

IMPLEMENTATION CONFERENCE
(HARVARD PROJECT PHYSICS)
July 15 - 17, 1970

<u>July 15</u>

3:30-4:00 p.m.	Registration	Parlors A & B Ramada Inn
4:00-5:30 p.m.	Opening Session Steve Winter - John Yegge	Parlors A & B Ramanda Inn
5:45 p.m.	Hospitality	Parlor C Ramanda Inn
6:45 p.m.	Dinner	Parlor A Ramada Inn

<u>July 16</u>

8:15-9:45 a.m.	Introduction to Harvard Project Physics Materials LeRoy Kallemeyn-Charles Lang	Rooms 216,219 Cardwell Hall
9:50-10:50 a.m.	Participation in Institute with Teachers LeRoy Kallemeyn -Charles Lang	Room 102 Cardwell Hall
11:00-11:30 a.m.	Discussion of Harvard Project Physics Course Steve Winter - John Yegge	Room 219 Cardwell Hall
11:45 a.m.	Lunch	Kramer Food Center
1:00-3:45 p.m.	Small Group Discussions: Implementation Problems	Room 219 Cardwell Hall
4:00-5:15 p.m.	Tour A.B.Cardwell	Room 219 Cardwell Hall
5:45 p.m.	Dinner Speakers - - Samuel Keys, Dean College of Education - A.B.Cardwell, Head Department of Physics	Kramer Food Center Summer Session Line

July 17

8:30-10:00 a.m.	Review of Implementation Problems Steve Winter - John Yegge	Room 219 Cardwell Hall
10:00-11:30 a.m.	Questionnaires; Question and Answer Steve Winter - John Yegge	Room 219 Cardwell Hall
11:45 a.m.	Lunch	Kramer Food Center

APPENDIX F

STATISTICAL TESTS USED

APPENDIX F

STATISTICAL TESTS USED

Kendall's S statistic is appropriate for evaluating relationships in contingency tables in cases where the table is asymmetric (one dependent variable and one independent variable) and where both variables are ordinal (i.e. have a natural ordering).[1] This statistic is more powerful against hypotheses of monotonic correlation than the traditional chi-square statistic, which is not sensitive to the internal ordering of the variables.

In cases where both variables were ordinal then, Kendall's S[2] statistic was computed. When the independent variable was nominal rather than ordinal, the independence of the two variables was tested with the chi-square statistic. In both cases, the 0.05 level of confidence was selected as an acceptable level to denote significance.

For 2 x 2 tables, where there is only one degree of freedom, Kendall's S test is equivalent to the chi-square test.[3] For convenience in computation, the significance of the monotonic correlation in such cases was tested with the chi-square statistic (with Yates' continuity correction applied) but is reported (where the independent variable is ordinal) as the significance of S.

Two measures of association were computed. For cases where the independent variable was considered to be ordinal (most of the cases), Goodman and Kruskal's gamma was used; where the independent variable was nominal, Goodman and Kruskal's Tau-b was used.[4,5] These measures of association were chosen from among the rather rich array of measures because of the very convenient interpretation which may be attributed to their numerical values. Costner has pointed out that both gamma and Tau-b represent the proportionate reduction in error made possible by knowledge of the relationship signaled by a significant Kendall's S or chi-square test respectively over the error that would occur without knowledge of the relationship.[6] The "error" for gamma and tau-b have slightly different meanings because of the difference in the type of independent variables. For gamma, one orders two subjects (randomly chosen and untied on the independent variable) on the dependent variable and takes gamma to represent the proportional reduction of errors in ability to make the ordering that the known relationship makes possible. Tau-b, on the other hand, involves reconstructing, by random assignment, the distributions of the dependent variable for each category of the independent variable based upon knowledge of the independent variable. Tau-b represents the proportionate reduction in error in making the assignments made possible given the knowledge of the relationship over those assignments made without such knowledge.

Principal components factor analysis was used in an attempt to determine the number and nature of the variables which presumably underly those which prior analysis showed to be related to the expectation of adoption -- the dependent variable. Analytic rotations of N orthogonal axes (one axis for each of the N factors) was performed by the Varimax method[7] proposed by Kaiser in order to maximize the "loadings" of the N factors each on a single axis while minimizing the loadings on each of the N-1 other axes.

APPENDIX F

Footnotes

1 E.J.Burr, "The Distribution of Kendall's Score S for a Pair of Tied Rankings," Biometrika, 47:151-165, 1960.

2 The Kendall's S statistic is often presented as a signed number to indicate the direction of the monotonic trend. Except for special cases in this report, however, where S is reported with no contingency table, the sign of S is omitted. Examination of the contingency table readily reveals the directions of the relationships.

3 Burr, ibid. p.164.

4 L.A.Goodman and William H. Kruskal, "Measures of Association for Cross Classifications," Journal of the American Statistical Association, 49:732-764,1954.

5 Gamma and tau-b are signed numbers, the sign, like that of S, indicating the direction of the relationship. Our interest in gamma and tau-b, however, is in their magnitudes. Since the directions of the relationships are evident by inspection of the contingency tables, only the absolute values of gamma and tau-b are reported.

6 Herbert L. Costner, "Criterion for Measures of Association," American Sociological Review, 30: 341-353,1965.

7 The DATA-TEXT System, Preliminary Manual. Cambridge, Mass.: Harvard University Computing Center, June, 1969.

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